An Analysis of Different Earthen Building Foundation Methods

The Purpose Of This Comparison Report

This comparison of two different types of natural building foundations is intended to provide basic information about options for making building foundations on a low budget without having to involve the services of expensive paid contractors and their employees. Only two different types of foundations will be compared in this writing for the sake of keeping things short and focused. **Dry Stack / Loose Rock** foundations and **Old Rubber Tire** foundations will be evaluated here because they seem to be the most practical choices for people looking to construct building foundations themselves. This analysis of two different foundation types is primarily targeted at people who intend to build their homes themselves on a meager budget; however, this comparison is also useful for architects and building contractors interested in expanding their client base by offering foundation building options which are both less expensive and more environmentally conscious.

Introduction

When an owner-builder of an earthen home decides to begin construction, the first steps are obviously surveying of the land location and then clearing and preparing the chose spot for construction. After the chosen spot for erecting the building has been selected and the brush and plants have been removed from the building site, the process of construction can begin in earnest. The first phase of the actual construction process in any building involves laying the foundation. Foundations are truly critical to the building process because foundations are what gives a building stability and longevity over the coming years of use and occupation. A solid building foundation is essential to prevent a building's walls from falling down, developing cracks, or having the building get destabilized after a time of prolonged wet weather. A good building foundation will be constructed in such as way as to ensure that the building will survive earthquakes, floods, and winter freezes without trouble.

Every building needs a solid foundation which will be able to withstand earthquakes, floods, and possibly winter freezing, but an owner-builder on a budget might want to consider which options will enable him or her to construct a building foundation on their own which will provide solid footing for their building at an affordable price.

Background: Common Dangers to Building Foundations

Flooding

Flooding can take different forms. Sometimes flooding can take the form of a protracted period of rain which never allows the ground to dry, thus giving the ground a pudding-like consistency which can leave houses on hillsides sliding down the slope on which they were built. Other times protracted periods of rain leave the ground so soft and saturated that the weight of buildings pushing down on their foundations causes uneven loading on one or more parts of their foundations thus resulting in damaged foundations, cracked walls and floors, and possibly roofs becoming detaching from the rest of the building. Cracked walls and floors often allow cold air and water to enter buildings, thus making these buildings much less usable.

Sometimes flooding is characterized by heavy rains over a very short period of time which create large flowing streams of water that in turn move dirt around underneath building foundations creating uneven pressures along foundation walls. Foundations undermined by swift moving water eventually lead to structural problems and expensive building repairs. Buildings of all types which are located on flood planes and hillsides are particularly vulnerable to having moving water remove portions of the soil where these building foundations rest, thus compromising the entire structures of these buildings.

As mentioned by Quentin Wilson is his article about adobe building foundations featured on the website greenhomebuilding.com, rubble trench foundations are popular with the natural building community; however, these types of foundations are troublingly vulnerable to getting completely destroyed and undermined if water is flowing with any speed where these foundations are constructed. A rubble trench foundation is a popular choice for may earthen construction home builders because they are very cheap and easy to make; however, rubble trench foundations are essentially just ditches in the ground filled with gavel and perhaps a set of rocks or bags of gravel on top. Rubble trench foundations may have a long history of use in the Middle East and India; however, their vulnerability to damage from flowing water makes them rather poor choices when evaluating them for flood resistance. Because of their poor flooding resistance rubble trench foundations will not be evaluated in this writing.

Earthquakes

Earthquakes are more of a problem in certain parts of the world than in others, but earthquakes can happen absolutely anywhere, so it is always essential to design and construct building foundations with earthquakes in mind. Countless millions of people around the world live in very earthquake prone places, and the rim of the Pacific Ocean is one such zone where untold millions of people live in areas which are very tectonically active. Some Pacific Rim areas of intense earthquake risk and high population density are Japan and California. The West Coast of South America is also one of the Pacific Rim earthquake danger areas, and this region is particularly vulnerable to earthquake damage because of all the adobe brick building in use. Earthquakes have wreaked terrible havoc on the population of Peru over the years because estimates furnished by the Built Construction Journal of India indicate that around half of the population of Peru lives in adobe brick homes which are not designed by architects or built by licensed building companies and are not well prepared to withstand earthquakes.

One of the best ways to make any earthen building more resistant to earthquake damage is to construct the earthen building with the best possible foundation. A solid foundation is a good defense against earthquake damage to an earthen building because a building with a solid foundation will move less when the ground shakes and is therefore less likely to have it's walls or roof to fall in the event of an earthquake. Aside from the issue of walls toppling or cracking when an earthquake strikes, building foundations should be able to withstand the shaking of a strong earthquake without becoming damaged themselves. After every major earthquake conventional cement foundations are damaged in some way by the millions, thus wracking up billions of dollars in repair bills over the coming years; however, some types of foundations are better at withstanding damage from earthquakes than others.

Freezing

Admittedly, freezing is not a problem in every part of the world, but in places with colder winters both “Heaping” and cracking can be a real problem to building foundations not designed to properly withstand winter temperatures below the freezing point of water. The following information relating to building foundations getting damaged from heaping and cracking, and the information presented relating to insulated foundations was provided courtesy of the website concretenetwork.com .“Heaping” is the process where frozen water in the soil expands as it freezes, thus causing the ground to expand upward in heap-like and sometimes wave-like formations. Heaping typically happens when the soil surrounding a building has at least 80% moisture saturation and a high silt content. Foundations typically rest below the official frost line for a given location because the ground typically remains at a constant temperature of around 55 degrees fahrenheit once the frost freeze zone is passed. Heaping typically happens at shallow depths and involves pressure being exerting in a horizontal or sideways manner on building foundations. The lateral pressure exerted by heaping ground can lift certain portions of foundations not set to sufficient depth, thus creating uneven pressure on different sections of a building’s foundation. Eleven pressure on building foundations caused by heaping often lead to sever building damage and expensive repairs.

Insulated foundations are able to be set much shallower than conventional foundations because the insulation surrounding these types of foundations acts as cushioning against lateral pressure from heaping. Insulated foundations are also able to resist heaping better because they do not conduct cold like single piece uninsulated cement foundations and thus are able to allow warmer temperatures from below to rise and remain in the main material of the foundation itself, allowing this style of foundation to keep frozen ground at least partially at bay.

The freezing of water in soil can also cause soil to expand and potentially crack inflexible cement foundations. In places of truly extreme cold such as certain parts of Siberia and Alaska heaping is such a problem that many buildings do not rest directly on the ground but instead sit on top of wooden stilts attached to small cement pier blocks located above the ground. Because of the possibility of ground warping during times of very cold weather, different regions of the world have differing requirements concerning foundation depth. Buildings around the world are typically expected to rest at least six inches below the calculated depth of soil freezing for the area where they are constructed. The colder the place of construction, the deeper the foundational depth requirements tend to be. For instance, as published on the website decks.com, the state of Florida has an official frost line depth of one inch, whereas Minnesota has a state minimum frost line foundation requirement of 60 inches. In the most northern part of Minnesota the foundational freeze depth requirements are a staggering 100 inches or around nine feet.

Another problem which extreme cold can pose to cement building foundations is the possibility of cracking internally when cold arrives. Cement and lime mortars are porous materials which means that water will saturate anything made of these materials through capillary action, thus the internal water stored in cement increases the possibility of cracks forming in the material as trapped water freezes and expands during the winter months.

Why Conventional Cement Foundations Will Not Be Compared In This Report

Conventional poured cement foundations will not be covered here because they are typically expensive and not well suited to those wishing to build the foundations of their construction projects themselves. Conventional foundations are expensive because the process typically involves a contractor, subcontractors, and a team of the contractor's workers putting in a lot of paid labor. The high total cost of paid labor when hiring a cement contractor to install a conventional building foundation is incurred by the need for the contractor's crew to set up large molds for pouring big slabs of relatively expensive cement. Aside from the advantage that other foundation types offer on money savings and providing the possibility to building a foundation without involving a contractor, conventional foundations are really not all that great even after they are built. One of the problems with conventional cement foundations is that the builders typically internally reinforce the cement making up the foundation with cheap steel bars to help make the poured cement structures stronger. Information published at theconstructor.org; describes how metal reinforcing bars embedded in poured concrete structures chemically react with surrounding cement resulting in structural problems for the entire steel reinforced poured piece. Estimates place the real working life of a steel reinforced cement bridge at about 50 years, and after as little as 25 years many steel-reinforced poured concrete structures are already showing serious signs of internal structural degradation.

Aside from internal chemical reactions weakening steel reinforced cement over time, any foundation built with concrete or even lime mortar is going to be prone to moisture wicking. Building contractors frequently have to repair damage to buildings resulting from water seeping up from cracks in cement slab foundations as well as the problems associated with water damaging wood where the tops of cement foundations meet wooden wall studs. Because of the wicking problem, cement and lime foundations need a layer of sealant to prevent moisture damage to other sections of the buildings sitting on top of these foundations. Conventional cement foundations also have problems resisting earthquakes and frequently crack when the ground shakes. Last but not least, conventional cement foundations are quite expensive to repair if they have been damaged by floods, freezing, or earthquakes.

Types of Foundations Being Evaluated

For the sake of brevity only two types of foundations will be evaluate here. Each type of foundation being evaluated here was chosen because it is inexpensive, can be constructed without the help of a cement contractor, and does not wick moisture like a cement or lime foundation. Each type of foundation being evaluated will also have to be able to extend out of the ground at least 18 inches because all earthen construction walls must have at least 18 inches of foundational clearance from the ground in order to avoid water damage to the walls in the event of flooding.

Loose Rock/ Dry Stack Foundations

The **Loose Rock** or **Dry Stack** style of building foundation is made by stacking rocks without mortar. This style of foundation works best if the rocks are stacked in wide piles and placed in a trench for additional stability. To achieve the same level of stability as a conventional building foundation wall, a typical dry stacked stone foundation wall will have to be around two and a half times wider than a conventional poured cement foundation. This style of foundation has been quite popular for earthen buildings for thousands of years. The dry stack method of foundation

construction often uses wedge shaped flat stones stacked with the narrow sides of the stone wedges facing inward towards the center of the wall. The practice of setting the stones in a dry stack wall in such as way as to slide inward is employed so that the rocks making up the wall will fall or slide into the center of the pile in the event of an earthquake or simply slide inward as the foundation wall settles over time. Aside from flat rocks, round river stones, and quarried granite boulders of different sizes can be used to successfully make dry stacked stone walls and building foundations.

Many old buildings around the world have successfully used the loose stack type of foundation for many millennia; however, this practice has become far less common in recent centuries because lime and concrete have become the material of convenience for constructing building foundations. The Appalachian Mountain region of North America has a long history of using dry rock to build entire buildings, retaining walls, bridges, and the foundations of wooden buildings.

Above photograph of a dry stone foundation is provided courtesy of **The Drystone Conservancy. drystone.org**

Above photograph is depicts a dry stone foundation. The above photograph is provided courtesy o**f The Drystone Conservancy. drystone.org**

Old Rubber Tire Foundations

The **Old Rubber Tire** type of building foundation is made by filling a trench with layers of old tires and in turn filling these old rubber tires with tightly compacted gravel of one type or another. At this time, the practice of using old rubber tires packed with gravel for building foundations is still a new and novel idea and has not gained any mainstream acceptance; however, awareness of this foundational construction technique is spreading quickly.

The entire concept of constructing building foundations from gravel and old tires is less than a decade old and has not been widely practiced at this time; however, some non-profit organizations focused on building homes for very poor people living in very poor countries have developed considerable expertise and gained a lot of valuable experience by building many of these types of foundations in recent years. An example of one such non-profit organization which has embraced the Old Rubber Tire style of building foundation is Abundant Edge. In America and Europe there is now a small number of tiny "Green" construction companies who offer consumers the possibility of having a cheap Old Rubber Tire foundation put under their new home addition or custom home build. One such cottage industry rubber tire foundation building company in the United States is Les Virgen Bases. Companies willing to build new Old Rubber Tire foundations are likely to see their numbers increase in the coming years because all that is required to get started in this line of work is a pickup truck, a few simple tools, and a few people willing to put in some hard work.

Photo at left shows a completed tire and gravel foundation ready for the next phase of building construction. This photograph was sourced from: **abundantedge.com**

Photo at left depicts a gravel and old tire building foundation under construction. This photograph was sourced from: **abundantedge.com**

The photo at left depicts an Old Rubber Tire foundation being built to support a conventional wooden framed home. This photo was furnished sourced from: **lesvirgensbases.com**

The above photograph depicts an Old Rubber Tire type of foundation under construction in the United Kingdom. Photograph sourced from:
inglepingle.co.uk

Foundation Evaluation Criteria

For the two types of foundations being evaluated here the criteria of flooding will not be covered because both Old Rubber Tire foundations and Loose Rock/ Dry Stack foundations are not particularly vulnerable to being damaged by flooding. As mentioned earlier, flooding effects gravel trench and conventional foundations the worst, and for this reason and others neither of these types of foundations will be analyzed in this writing. As mentioned by Quentin Wilson on greenhomebuilding.com, gravel trench foundations can get completely washed out in the event of an intense moving water type of flooding situation, particularly if the gravel trench is set up on a hillside. Conventional cement filled trench-style foundations are also particularly venerable to being undermined in a flowing water type of flooding situation due to often having very narrow bases. Because of their wide bases, both Old Rubber Tire foundations and Loose Rock foundations will still maintain structural integrity even if the walls of their foundational trenches are completely washed away.

Loose Rock foundations, if made sufficiently thick and placed at a decent level below the land grade of the building site they occupy have very little vulnerability to damage from flowing water. In parts of China and other places there has been a very long tradition of people safely building homes and other buildings in known flood plane areas so long as the buildings had high and secure Loose Rock foundations which would be above eventual projected flood water levels. As Quentin Wilson mentioned, there is a long history of earthen buildings being safely constructed above ornamental ponds so long as these buildings sit on good Loose Rock foundations. Loose Rock foundations are possibly the best choice for resisting flooding because they really can not be easily damaged by water in any way, and they simply do not wick water up to the building above.

Cost
How expensive is it to build a foundation of this type.

Labor
Aside from cost of materials, people looking to construct their building foundations themselves have to consider the amount of work involved and the physical demands of the work in question.

Earthquake Resistance
How well does this foundation type withstand earthquakes.

Freezing Resistance
This criteria examines how cheap and easy it is to construct a cold tolerant foundation using this method.

Atmospheric Resistance
Some newer types of foundation construction use synthetic materials, and these petroleum based synthetic materials are vulnerable to accelerated degradation from atmospheric factors over a long period of time. Such atmospheric catalysts to the degradation of synthetic materials are: exposure to atmospheric oxygen, exposure to atmospheric ozone, exposure to heat, and exposure to UV radiation in the form of sunlight.

Sources of Research Information

Research Sources For Loose Rock/ Dry Stack Foundations

Online resources and information about these types of building foundations were not very extensive; however, two resources provided sufficient information to complete this foundational assessment. The first and most extensive resource examined was The Drystone Conservancy located in Lexington, Kentucky. The Drystone Conservancy is a nonprofit organization which is dedicated to preserving the traditional practice of building all sorts of structures from loose dry stones. The Drystone Conservancy is dedicated to preserving this craft because they believe this method of construction offers an easy and cheap way to build many different types of structures, structures made of dry stacked stone last a long time, and this type of construction is also very environmentally friendly. The other source of research information about dry stone building was an article on the greenhomebuilding.com web page written by Quentin Wilson which discussion the different types of foundations used for adobe construction.

drystone.org is The Drystone Conservancy's webpage

Foundations for Adobe by Quentin Wilson found in web site green homebuilding.com, no date posted

Research Sources For Gathering Information About Old Tire Foundations

Information about used tire foundations can be found online; however, this information is scattered around in a collection of different short posts on several web pages.

Owen Geiger Naturalbuilding.blog 03/29/2009 This article by Owen Geiger was a wonderful source of information concerning Old Rubber Tire foundations and cold weather. This is the place where I learned about insulated foundations and Old Rubber Tire foundations made with packed scoria gravel.

Building A tire Foundation by Jay Warmke, article posted on web site bluerockstation.com, no date posted

Tires Are Safe, author not listed, found on the web site greenhouseofthefuture.com, no date posted. This is the place where I learned about atmospheric degradation of tires from heat, oxygen, ozone, and sunlight.

Recycling Old Tires by Bill Sitkin found on the web site greenhomebuilding.com, no date posted

Tires Used to Build Earthquake Resistant Homes by Marisa McNatt found on the website earth911.com 03/12/2010

greenbuilding.com natural foundation sealants section

Research Sources for Pricing Information

The costs of gravel and rock have to be evaluated when discussing either of the types of building foundations examined here, as does the cost of having a conventional foundation installed for the purposes of comparison and reference.

homeadvisor.com has provided basic information about the costs of conventional foundations and gravel by the ton.

grenbuildingsupply.com has provided basic information and pricing concerning environmentally friendly foundation and basement sealants.

contractors-stone.com has provided basic information about the number of tons of rock needed to construct dry stone foundations and the approximate per-ton costs of different stacking stone choices.

Discussion of Findings

Loose Rock Foundations

Cost

Loose rock foundations will typically cost about half of what a regular cement foundation costs if basic flat limestone pieces are used. Basic flat limestone pieces cost around 128 dollars per ton because they are not very processed and are typically somewhat large and have rough edges. A loose stacked foundation built with basic flat limestone pieces will have a rougher appearance with larger gaps between the stones, but the larger rock sizes will still ensure sufficient wall stability and strength. A conventional foundation typically costs around seven dollars per square foot of the home it supports, so a loose rock foundation will have a price of $ 3.50 per square foot of the home.

If a builder chooses to use fancy decorative quality loose-stack rocks which are dedicated for use in retaining walls the cost will go up to around 375 dollars per ton for the materials. Dedicated decorative dry-wall stacking stones are typically much smaller than basic limestone flat rocks, but they are cut to fit together much more tightly and precisely, thus creating solid structures with these stones is still very easily done. If fancy trimmed retaining wall stones are used, the cost of this type of foundation will be approximately 80% the cost of a conventional cement foundation. The advantage to using dedicated retaining wall stones is not so much a question of strength or wall integrity, it is more a matter of appearances. Dedicated trimmed stacking stones give the foundation walls an elegant look when finished.

Labor

Loose rock foundations are an excellent choice for those looking to build their homes themselves without involving contractors. Building a dry rock foundation wall is typically not back-breaking work and requires no power tools, heavy equipment, or messy cement mixing. Building a dry stone foundation involves a type of labor that is more focused on careful thought and patient placement of rocks than physical exertion. Some people really enjoy this patient and thoughtful type of work and some do not. One person can typically build a dry rock foundation with one week of full time work. If dedicated stacking stones are used no tools except levels and string will be needed. If heavier lime stone flat rocks are chosen a simple stone chisel and hammer might be needed to help some pieces fit together more soundly.

Earthquake Resistance

Loose Rock foundations are a good choice for new building construction because they are relatively inexpensive and do not have a problem with water wicking up the foundation and wetting the earthen walls; however, these types of foundations are somewhat more vulnerable to damage from earthquakes than other types of foundations such as Old Rubber Tire foundations or wooden piling foundations. The rocks which make up these foundations are stacked loosely without mortar, for this reason, loose rock foundations are somewhat more prone to shifting in the event of an earthquake than other types of foundations; however, a decent and well made dry stack building foundation has about the same earthquake resistance as a conventional cement foundation. One nice selling point for Loose Rock foundations is the fact that if these foundation types are damaged in an earthquake they are very easy and cheap to repair: unlike conventional cement foundations. Despite having some vulnerability to earthquake damage many earthen buildings which were constructed in very earthquake prone places have successfully stood for centuries.

Freezing Resistance

Loose Rock foundations rate quite favorably when compared to lime mortar or cement foundations when evaluating for resistance to damage from cold weather. Because loose rock foundations are not made of porous material they do not wick water and are less prone to cracking over time than a cement or lime mortar foundation. Unlike some other types of foundations, loose rock foundations will not qualify as insulated foundations and so full excavation depths for whatever the soil frost line is for the place of building will have to be met.

Atmospheric Resistance

Loose Rock foundations are made of inert rock, thus there is no concern about materials breaking down in the sunlight or oxidation destroying the foundation materials, as is the problem with certain other foundation types. Loose rock foundations also do not have the problem of internal chemical breakdown that results from cement reacting with internal iron reinforcing bars as is typical of conventional cement foundations. A well built dry stacked rock foundation will pretty much last indefinitely and will never suffer any issues from atmospheric or internal degradation.

Old Tire Foundations

Cost

Old Rubber Tire foundations can potentially cost almost nothing to build; however, it is best to assume that an Old Rubber Tire type of foundation will cost about a fifth of what a regular foundation would, thus putting the cost of a tire foundation at around 1.40 per square foot of the building. Many tire centers will give away old tires for free because tire centers have to pay to dispose of their used tires. The problem with obtaining tires for free is that it may be difficult to obtain tires of the same size. If an old rubber tire foundation is to be build with proper strength, the tires have to be the same size. If no tires are available for free in the immediate area of the construction project, tire recycling companies can typically sell people similarly sized sets of old tires for very modest prices.

As for the cost of the gravel which fills the tires, the price of regular road gravel is about 35 dollars per ton. If the tires are being used to make a foundation in a cold area and scoria rock gravel is chosen instead of regular gravel the cost will be around 70 dollars per ton for the scoria rock. Scoria is a contractor's trade name for light and porous volcanic rock also commonly referred to as pumice. Scoria gravel may cost more than conventional gravel; however, if this type of gravel is chosen to build an insulated type of foundation than a lot less gravel will be needed, thus choosing to pack the old rubber tires with insulating scoria grave will not drive up the cost of building the foundation as badly as one might assume.

When the main construction process of an old rubber tire foundation is complete, there is still a need for atmospheric sealing of the above ground tires, so the cost of buying foundation sealants will create an added expense. The foundation sealants used to finish these types of building bases typically cost about one hundred dollars for a five gallon bucket and depending on the size of the foundation, there will have to be many buckets of this sealant used before the foundation is completed. Another possible added expense for this type of foundation is the gravel skirt which goes on the outside of the foundation wall. Some people might want to invest in a bit of nice looking gravel to cover the atmospherically exposed bases of their old rubber tire building foundation walls, and decorative gravel typically costs around 75 dollars per ton.

Labor

Although the material cost of used rubber tires and gravel are not very high, building these types of foundations involves many hours of hard physical labor. The tires which make up the structure of this type of building foundation have to be filled with gravel and carefully packed with a tamping tool little by little for the tires to achieve the solid packed state with is needed for a decent tire and packed gravel type of foundation. This method of building a foundation will typically involve a few weeks of hard, long, and boring days of real physical labor for a do-it-yourself builder.

After the foundation tires have been packed and set in place the next step will involve painting the tires exposed to the atmosphere above the soil line with several coats of foundation sealing compound and then a few coating of house paint to cover the exposed dry foundation sealant. The tire sealing process is not back breaking work but it does add to the time and labor needed to complete this type of foundation.

Earthquake Resistance

Because gravel filled tires have wide bases and are quite heavy when fully compacted they provide a very solid platforms on which to place buildings. Because of the weight of the gravel packed rubber tires, these types of foundations tend to not move very much when the ground shakes. Of all the foundation types in existence today, the packed gravel and old rubber

tire type of foundation is debatably the best one when evaluating for earthquake resistance. Old Rubber Tire foundations are not solid pieces such as cement or lime mortar and stone foundations, so they are not prone to cracking when the ground shakes; no amount of ground shaking will result in a tire foundation having to be repaired.

Freezing Resistance

If Old Rubber Tire foundations are packed with light and porous gravel made from volcanic rock, commonly called **scoria**, they are considered to be the functional equivalent of **insulated foundations**. In most parts of the United States the winters are not really cold enough to merit an insulated foundation and packing the tires making up the building foundation with regular gravel will suffice. Even if an old rubber tire foundation is simply filled with regular gravel and buried below the required frost line this type of foundation is not going to be vulnerable to cracking from external lateral pressure exerted by the expansion of freeing ground nor will this type of foundation be vulnerable to internal cracking from trapped water expanding when frozen. The inherent flexibility of rubber and gravel makes this type of building foundation very hard to damage from freezing.

Regular cement foundations which qualify as insulated typically have layers of polyurethane foam insulation surrounding the foundation cement. In insulated foundations, the layers of foam insulation between the foundation cement and the frozen ground effectively keep the building from being effected by ground expansion due to freezing.

Insulated foundations are only required to be a around a foot deep in all but the absolute coldest of places. Even in the coldest of places insulated foundations rarely have to be more than two feet deep. Scoria gravel typically costs about twice as much per ton as regular gravel, but if an insulated foundation is used the amount of gravel will typically be cut in half. In cold climates such as the prairie provinces of Canada, old rubber tire foundations can save builders a lot of money on materials and excavation costs.

Atmospheric Resistance

Old tires tend to break down slowly over time when exposed to atmospheric oxygen, and they break down even faster if exposed to atmospheric oxygen, high temperatures, and UV radiation from sunlight. If a builder chooses to use an Old Rubber Tire foundation, care must be taken to make sure that tires are exposed to as little atmospheric oxygen heat, and sunlight as possible. Tires buried in the ground will break down very slowly over a period of centuries or perhaps even millennia; however, tires exposed to atmospheric oxygen and sunlight above the soil line will have to be covered in some sort of foundation sealant and gravel. Foundation sealant formulas will need to be used to cover all of the rubber exposed above the ground line to keep the tires from degrading from oxygen exposure. After the upper tires have been coated in foundation sealant, the foundation sealant itself will need to be covered from direct sunlight exposure with mounds of gravel.

Foundation sealant formulas are designed to be flexible and tolerant of oxygen exposure; however they are not designed to withstand prolonged and harsh exposure to heat or sunlight. Applying a few coats of paint over the dried foundation sealant layers will also help to prolong the life of an old tire foundation. Gravel, as opposed to lime or concrete is the material of choice for covering the exposed and sealed foundation walls of an Old Rubber Tire style of building foundation because gravel will not crack over time or wick water up to the bases of wooden or earthen building walls in the same way as a cement or lime plaster coating.

Aside from UV radiation and oxygen, heat also speeds up the breakdown of tire rubber, paint coatings, and foundational sealant coatings, so keeping the tires covered in soil or gravel to cut back heat exposure will help keep an old rubber tire foundation secure for a much longer

time. Foundation sealants are designed to last around 30 years with oxygen exposure but without exposure to sunlight or high temperatures; however, foundation sealants and paint coatings on the exterior base walls of a building will decay very rapidly when exposed to ultra-violet radiation and high temperatures. If a good skirt of gravel is kept over any foundation sealant and the layers of conventional house paint covering an old rubber tire foundation's atmospherically exposed rubber pieces, the foundation should not need any maintenance for at least 30 years.

Conclusions

From the standpoint of cost the clear winner is the tire foundation. A loose rock foundation is still relatively inexpensive compared to conventional foundations, but is still nowhere as cheap as a used tire foundation. When evaluating the two different foundation types discussed in this report on the criteria of labor the clear winner is the loose rock foundation. The Loose Rock/ Dry Stack type of foundation does not require a large amount of hard physical work like building a foundation out of tires and gravel. From the standpoint of earthquake resistance the winner of this comparison is clearly the Old Rubber Tire type of foundation, the Loose Rock style of foundation clearly does not handle earthquakes as well as Old Rubber Tire foundations. Freezing resistance is clearly in favor of the old rubber Tire style of foundation if scoria gravel is used. From the standpoint of atmospheric resistance the clear winner is the Loose Rock style of foundation. The Loose Rock style of building foundations will not be effected by oxidation or heat nor will it be susceptible to degradation from exposure to the ultra violet radiation found in sunlight.

If I had to pick one of the two types of foundations evaluated in this writing for my own home I would choose the **loose stone** type of foundation simply because it is not susceptible to atmospheric degradation. This type of foundation is more susceptible to earthquake damage than a tire foundation, but not having to worry about the materials making up the foundation of my home breaking down over time is a nice feature. If money is a primary consideration than the tire foundation is the ticket; however, I would rather pay a little more for something that potentially looks great and I do not have to maintain.