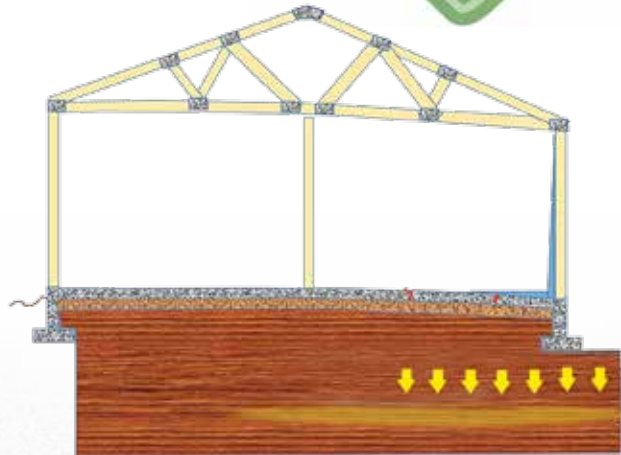
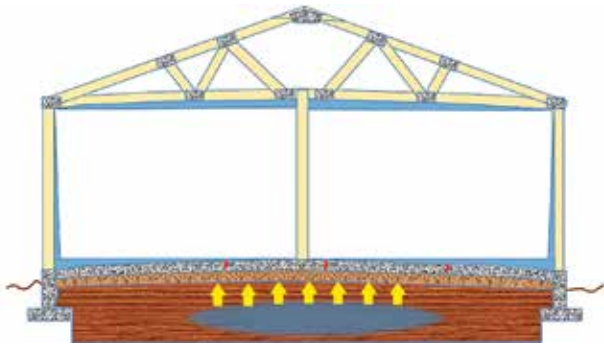




# Which way is my foundation moving?

A practical guide to understanding foundation repair



By Bob Brown

# CHAPTER ONE

## Why I wrote this book



I have been in business over 28 years and during that time I became involved in concrete leveling and underpinning. I have felt a ton of pressure to sell underpinning to every customer. Pressure came from a variety of sources: our industry suppliers, who are looking for us to sell their product, our salesmen in the field, who earn a living that is dependent on sales, and the workers in the field who depend on our sales to earn a living, not to mention our own bottom line and a desire to sell enough to break even every month.

It is frustrating to walk away from jobs that have serious damage and not sell any products or services to a customer who is pleading for relief. I have done just that for many years. It takes a tremendous amount of expertise, honesty and integrity to be forthright and not take advantage of the customer. I have prided myself and my company with these qualities since starting my business.

All across America, foundation contractors face the same battle. Many do not have the skills nor the will to distinguish between settlement and heave, and as a result many homeowners have been paying for repairs with little or no benefit and may actually be counterproductive.

I'm writing this book to help everyone understand the concepts and techniques to understand the difference between floor slab heave and footing settlement. Now after this it will be up to the homeowners and contractors to use this information in an honest and productive way.



*Robert K. Brown*

## About the Author



Bob Brown Graduated in 1984 from Arizona State University with a Bachelor of Design Science from the School of Architecture and a Bachelor of Science from the School of Business in Finance. In 1988 Bob founded Arizona Repair Masons Inc and in 2001 Arizona Foundation Solutions and has been operating them since then. Robert brings 30 years of construction experience is LEED Accredited and one of 2 Certified Foundation Repair Specialists (CFRS) in the State of Arizona. CFRS is a Designation of the Foundation Repair Association. Robert Completed the Grouting fundamentals course from the Colorado School of Mines in 2009. He has served as an expert witness in law cases on several occasions and is the holder of Patents 7914235 and 8096732 B2 issued in March of 2011 and a third patent pending. He is a EPA certified Radon measurement and mitigation specialist and a AZRE approved CEU provider.

## Technical Experts

Meet some of the experts who have supported out patent application for the MoistureLevel System.

These engineers have supported the development of the system with advice, technical direction.



### **J David Deatherage PE, *President, Copper State Engineering***

Senior geotechnical engineer specializing in soils and foundation investigations. Experience includes design and construction engineering on more than 40 flood control and mining related dams.

Most work is in Arizona, though we have worked in Jamaica, Peru and Mexico on several dam and mining related projects. Specialties: Investigating expansive and collapsible soils, design and construction engineering for dams and copper mining heap leach facilities, forensic investigations for geotechnical related failures



### **Ronald Starling PE, *President, Starling Madison Lofquist Inc***

Mr. Starling has been in continuous a practice as a structural, civil and forensic engineer since 1978. Has a broad range of experience in commercial ,

industrial and residential structural design as well as structural failure investigations, compliance studies and expert witness testimony. Mr. Starling been certified as an expert in structural engineering in both the state and federal court systems.



### **Claudia Zapata PhD PE, *Assitant Professor, Arizona State University***

Dr. Zapata was appointed Assistant Professor in the Department of Civil and Environmental Engineering at Arizona State University

in August 2006. She received her Ph.D. degree in Geo-Environmental Engineering from ASU in 1999. Dr. Zapata's primary research interest is in the area of unsaturated soil behavior. She has focused on fluid flow and volume change modeling for expansive soils,

with applications related to the behavior of pavement subgrades and slabs-on-grade foundation design.

At ASU, Dr. Zapata has been actively involved in the development of the new mechanistic-empirical guide for Design of New and Rehabilitated Pavement Structures, in the assessment of pavement performance due to environmental factors and in the study of fluid flow and volume change properties of expansive soils under slabs on grade residential foundations.



Have you thought about the motivations, credentials and science if any, that will go into repairing one of your largest investments?

## One of Your Larger Investments

### *Don't gamble... it's your home!*

It is no secret that most people's largest investment is their home. Even if it's not..... why would you unknowingly play smoke and mirror games with contractors in your principal place of residence?

Besides being your largest investment it's the place where you live! Isn't that the most important thing? Your family lives here, extended family and friends visit here and you spend a majority of your

time here. The last thing you need is a home that doesn't function properly.

So how much do you trust someone that you don't know to diagnose foundation problems with your house? Especially when they might have a vested interest in steering you in one direction or another to fit what they have to offer you....Could this happen?

Read on...





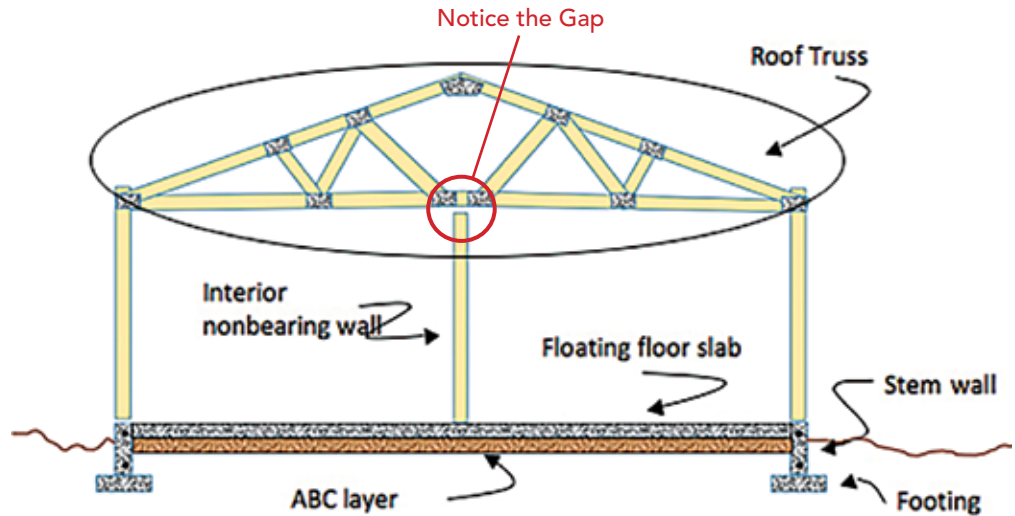
# CHAPTER TWO

## A Practical Guide to Understanding your Foundation



### Typical Conventional Foundation with a Floating Slab

Before we can discuss foundation problems and potential solutions, we first need to understand how foundations are built, how they interact with the soils and the interaction with the superstructure of the house components. I had a friend once tell me that all roads are dirt roads..... it doesn't matter whether you paint the surface with asphalt or concrete ..... its still supported and made primarily of dirt! Foundations work the same way....there are many types of foundation systems, 3 of which we will explore together, however it is paramount to remember that they all are supported by the soil. So we will want to understand some of the mysteries of soil and then how that soil interacts with each of the foundation types.



- This drawing represents a typical foundation throughout most of Arizona. This was predominately the way most contractors built prior to 2003.

- In this foundation the perimeter supports all of the roof loads which are distributed to the outer walls with the trusses on top.

- The interior floor slab is not physically connected to the stem walls and therefore it is considered a "floating floor slab".

- Notice the gap between the interior non loading walls and the truss. This is to insure that roof loads do not put weight on interior walls.

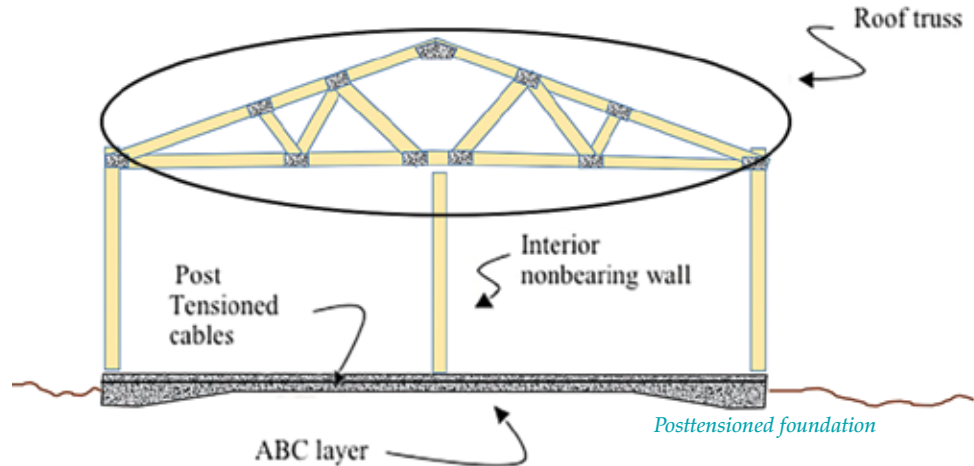




## HOT TIP

different foundation types react differently to geologic processes.

## Typical Posttensioned Foundation System in Southwest



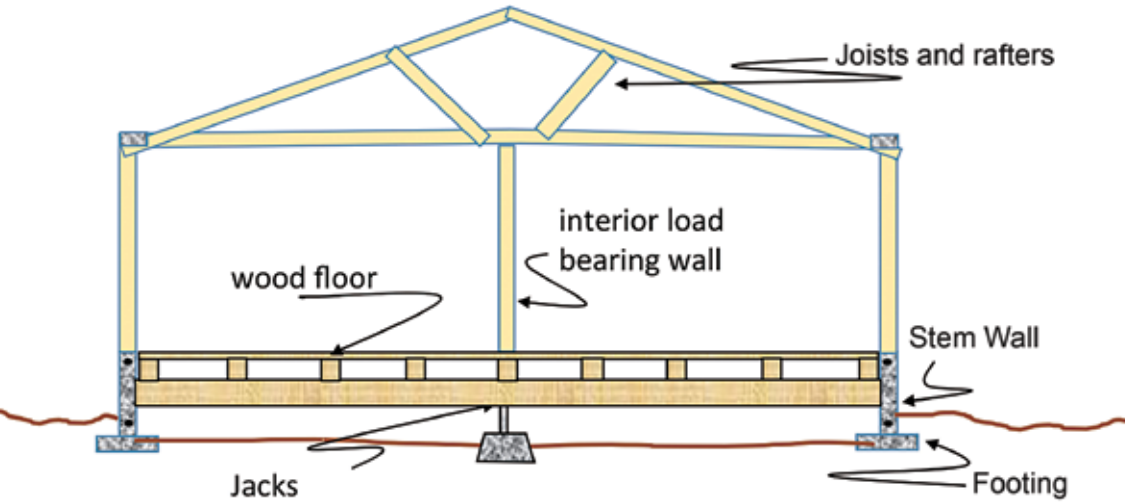
Around 2003 most builders in Arizona started transitioning to this type of Foundation system. As with conventional systems all of the weight is distributed to the perimeter by the trusses. The black line through the concrete represents a series of cables in both directions that are tightened up after the concrete is poured. The tightening of the cables puts the concrete in compression. Concrete is good in compression. This compression makes it stronger.

Concrete is weak in tension. The cables are great in tension and compensate for weak tension in concrete. The weakness in this system is that there is very little edge protection to stop water from getting underneath. It is also very vulnerable to heave since there are no spread footings to hold it down.

**CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION**

Many homeowners think that because they have a post tension foundation that they are safe from foundation problems. However, that is simply not true. We have repaired hundreds of homes with post tension foundation problems.

## Typical Crawl Space for Pier and Beam Foundation



This is the typical system that was used prior to about the 1960s most of the time. It usually has a crawl-space underneath that is elevated 12 to 24 inches to allow access underneath. Notice that there is no truss system above and therefore some of the walls on the

interior will help carry the roof loads on top. Besides the footings on the perimeter, there are interior jacks to support the floor from underneath.

*Another icon of  
the 1960's*





# CHAPTER THREE

## Soil Discussion... Heave Versus Settlement

**1.** Typically if you have a structure built over sands or silts and it does not get consolidated well enough and water infiltrates into that soil, you could see consolidation of the soils and settlement with the loads on top of it. This is the typical picture in our mind when we see damage in a house. It is the common meme in people's minds.



OK so hopefully we have a basic understanding of the foundation types and what they do. Now lets get dirty! The soil under every home is different. Not only is each different, but each has layers that get deposited over millions or billions of years with different chemical composition, density, water contents and particle sizes. Primarily it is going to consist of clays, sands/silts, gravels and rock.

Each of these have various mineral make up and compositions that we wont go into here.

When the lot is developed the builder cuts and fills the highs and lows to provide the levels needed to build houses, streets and neighborhoods. As a result some of those various layers end up closer to the surface than others because the layers are not flat, uniform or level. Each of them conduct water differently and react to water differently. The result is a dynamic constantly changing soil system at each location that is almost always in flux. Think of a seven layer chip dip where each of the layers always changing.

## Dirt on Soil Discussion

Let's talk about how Clay behaves versus the way sands and silts behave. Clay particles typically are smaller by orders of magnitude more than silts and sands. Clay particles are typically so small that they require a microscope to look at. Clay particles typically have an affinity for water because they are negatively charged ions which means they have suction and pull water, which is a positively charged ion towards them and in doing so on the whole increase in volume like a sponge does when they get wet

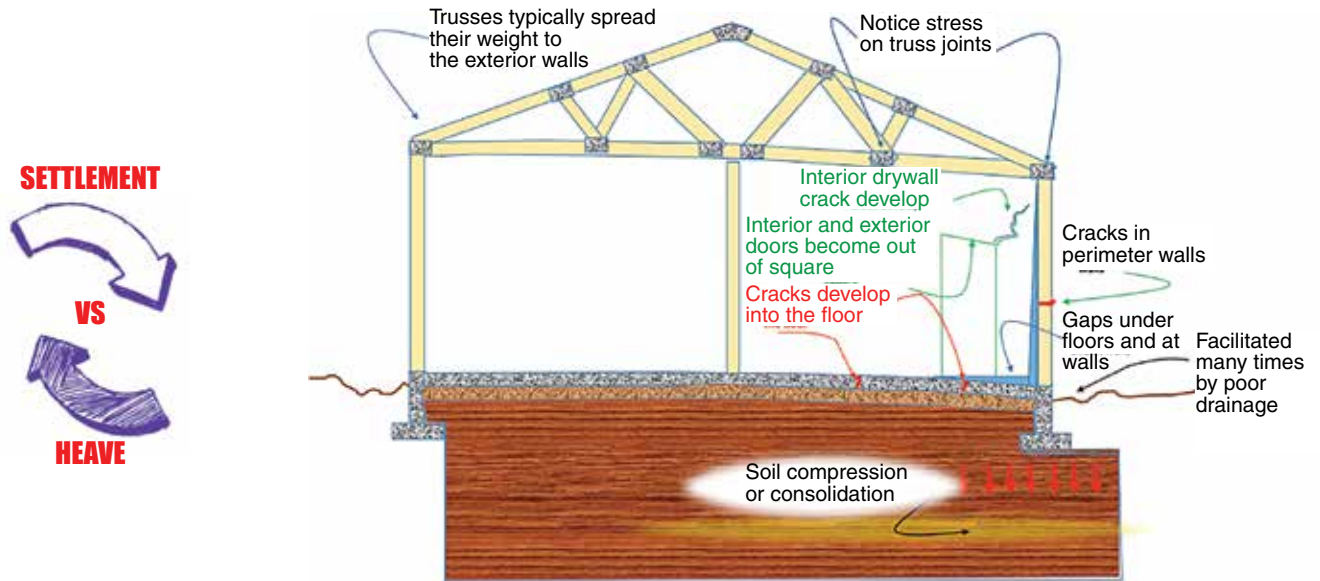
and shrink when they dry out. Clays also can, if they become oversaturated, become very collapsible. This is what makes diagnosing their behavior so difficult. Sands and silts on the other hand are usually easier to understand in that they usually don't have much swell potential to cause heaving. They typically consolidate with additional moisture and pressure if they are not compacted enough to start with. Soils usually behave in 1 of 4 ways.



**2.** If your structure is built over Clay soils and those soils dry out, then the Clays shrink and again the house settles. This is the common problem that occurs in most houses especially in climates that are wetter. The soil has been wet for millions of years and when you put a structure on top ...it tends to dry out. Especially if the climate gets drier because of droughts.



## Soil Discussion... Heave Versus Settlement



**3.**

It is possible that if your house is built on top of clays and these clays become supersaturated that they could collapse and cause settlement again. We see this in some of the spectacular mudslides on the California, Oregon, and Washington coasts and does happen on micro scales infrequently.



**“Clay particles increase in volume like a sponge does when they get wet.”**

## Soil Discussion... Heave Versus Settlement

4.

But what about the fourth scenario? What happens if your house is built over clays that are very, very dry and perhaps over compacted, and accumulates a very small addition of water? The Clays then absorb that water and begin to swell. The path of least resistance is up. These are very powerful forces..... in many times they could lift a structure, break concrete, and even bend steel. Or if your house is built on top of existing clays and a basement is dug out..... now you have removed hundreds of thousands of pounds of soil that was compressing the soil right underneath it for millions of years. Now all of a sudden that weight is removed. How do you think those Clays are going to react? Exactly right. They will heave up.

**“Wet clay soils can lift a structure, break concrete, and even bend steel.”**



**CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION**

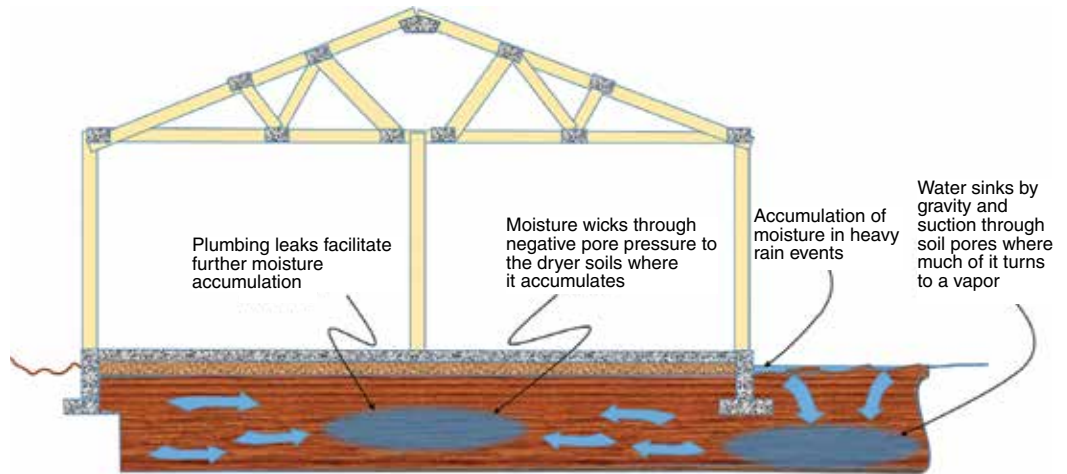
Most homeowners have no idea that their foundation movement can move up or down. Cracks in walls may not necessarily mean settlement. It could in fact be the opposite. Spending money on foundation settlement technology for heave problems is a recipe for wasted money at the least and possible disaster.



## Soil Discussion... Heave Versus Settlement



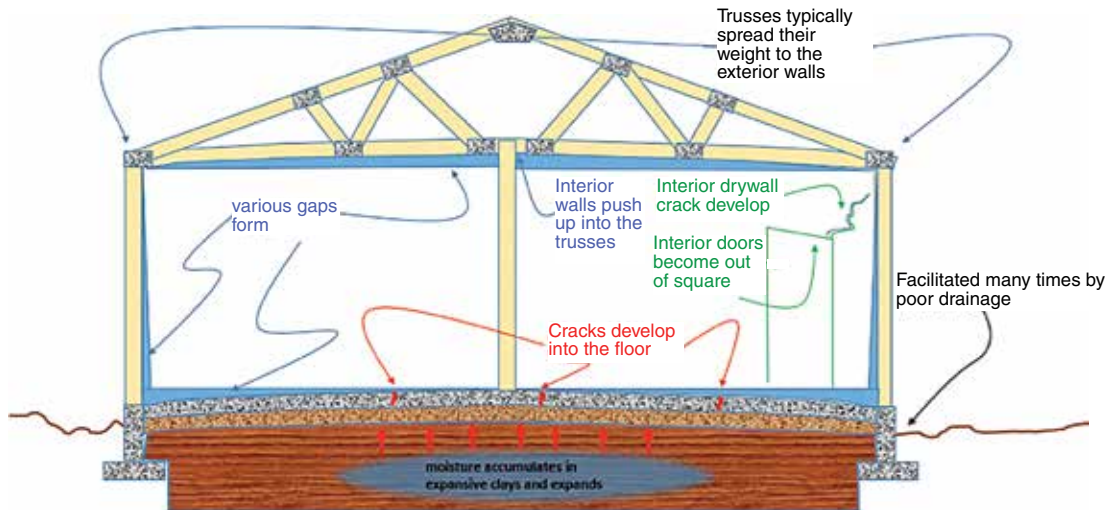
Heave or Settlement?



This is a typical illustration of how moisture accumulates under a structure

Looking at a typical conventional foundation system it is easy to see that a small footing could settle with a lot of roof load on it. It might not be so easy for that small footing to heave up from the soil although it could happen. Now let's look at a floor slab. The floor slab has very little weight on it. None of the roof

loads typically bear on interior slabs, and humans and furniture in the grand scheme of things don't amount to very much. This is a large area for soil to interact with. It is easy to see that it could be easily pushed up by forces from below and much more difficult for it to settle.





# CHAPTER FOUR

## The Dirty Little Secret of the Foundation Repair Industry



When a Home owner calls out a foundation repair company to “get a free estimate” it is a little known fact that many times the foundation repair contractor gives an estimate for repairs when often the repairs that are totally misdiagnosed and many times do more damage than help the house. This is common all across the country. The homeowner is not an expert in this area and has no idea if the recommended repairs are the right thing to do or not. They know the house has damage, but really is at the mercy of the foundation contractor to evaluate and recommend repairs that are the right thing to do.



**Why does this happen so regularly? There are several reasons:**

The contractor receives all of its training from a single source supplier. While this training in many cases is excellent, it tends to steer recognition and recommendations toward a single problem and solution, to the detriment of recognizing other problems that they don't have solutions for.



### ACCEPTED STANDARD PRACTICES

Are there a set of rules to follow in doing a foundation Investigation? In a word YES! The Foundation Performance Association and the Texas Chapter of American Society of Civil Engineers have booth laid out standard procedures. Most foundation Repair contractors Don't want you to know this.



How would you feel if you went to the doctor, and you found out he was only a pharmaceutical rep and he only prescribed one type of medication for every ailment?

**CONSUMER  
ALERT**

*Don't Get  
Ripped Off!*

**Is the Fox guarding  
the hen house?  
Fact: Commission  
based salesman  
sell bigger jobs!**



# 10 questions your foundation inspector may not want you to ask.... for you to protect yourself

**1.** Are you the fox guarding the hen house? (if you find a large area to fix, are you paid a commission on how much you sell?)

**2.** Are you following any recognized industry standard procedure for the foundation investigation? ( or are you just looking at things with your own agenda)

**3.** Are you doing any industry standard recognized scientific analysis? (or are you just shooting from the hip with on the spot with first impression, rough gut feel?)



**4.** Is there any engineering oversight for this? (Or are you just ACTING confident?)

**5.** Have you received any credible training other than a single source supplier? ( thus able to only recognize problems that match up with that suppliers products offered)

**6.** Do you follow any objective measurement standards of measuring the severity of the problem? (or do I have to rely on your subjective assessment?)

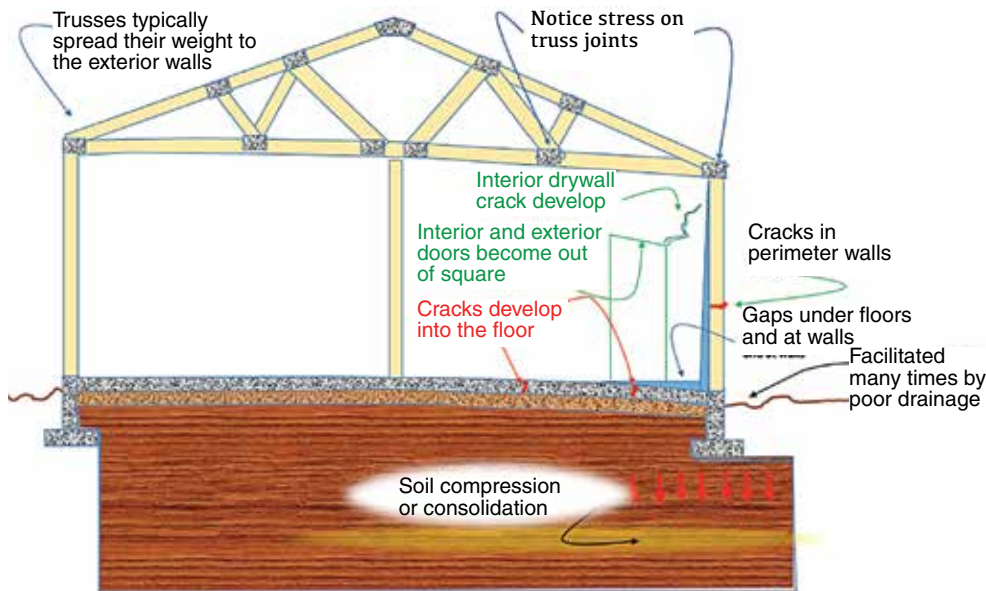
**7.** What is your reputation on Google, Yelp, Angies List, BBB and/or Rosie Romero? (if you have none..... why?)

**8.** Do you care enough about me to write down all of my goals and objectives for this and communicate it to everyone in your company?

**9.** Will you be pulling a permit for this? (if not when I sell this house someday, will I pay a price when I disclose that the work was done without a permit?)

**10.** Will I receive plans and drawings stamped by an engineer? Or will I receive your off the cuff plan? If I receive a plan later from an engineer..... how do I know that it will not change drastically?

## The Dirty Little Secret of the Foundation Repair Industry



Putting square pegs into round holes is frustrating.

*GOT ETHICS?*

Most foundation repair contractors don't want to be held accountable for distinguishing between settlement and heave.

Most foundation repair contractors are professionals. They wouldn't take advantage of home owners.... Would they? How and why could this possibly happen? It all starts with understanding soils. The thing supporting your foundation. Remember the 2 basic types of soils. Clays and silt/sand. Recall that silt and sand are fairly straightforward and when wetted they usually consolidate and therefore are fairly easy to understand. Clays on the other hand, swell when wetted, shrink when dried and collapse when wetted too much.

To make matters worse, the typical damage signs in a house look very similar when it is settling to when the floor is heaving from expansive clays. Yes that is right. Clays under your home can cause the floor to heave upward. Take a look at the two scenarios to understand what I am talking about.

The diagram at above shows the typical scenario that we usually think of when we have foundation problems.

This the scenario that foundation contractors understand well and are well equipped to fix. Notice that the footings on the right side are lower causing stress to the trusses above. This is commonly repaired by underpinning the lowered footing and raising it up.

### CONSUMER ALERT

Don't Get Ripped Off!

**Does your contractor have all possible solutions to your foundation problem, or just products a they represent?**

**Tip: If a contractor carries only one product line they may be biased in their recommended solution so they get the sale!**

The diagram illustrates a cross-section of a house with a gabled roof. The roof trusses are shown in yellow, with blue arrows indicating they spread their weight to the exterior walls. The interior walls are blue, and the floor is shown with a concrete slab and a layer of soil below it. Red arrows point to the floor, indicating that cracks develop into it. The foundation is shown as a brown, textured area. A blue puddle of water is shown in the center of the foundation, with a label indicating that moisture accumulates in expansive clays and expands. This expansion is shown pushing up against the floor slab. The diagram also shows that interior walls push up into the trusses and that interior doors become out of square. The diagram is labeled with various gaps forming and interior drywall cracking. A note on the right side of the diagram states that this situation has facilitated many times by poor drainage.

Trusses typically spread their weight to the exterior walls

Various gaps form

Interior walls push up into the trusses

Interior drywall crack develop

Interior doors become out of square

Cracks develop into the floor

Facilitated many times by poor drainage

moisture accumulates in expansive clays and expands

Surely the professional foundation repair contractor knows the difference between these 2 scenarios..... Right? Not necessarily.... As pointed out earlier the symptoms are similar and in some cases exactly the

**CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION CAUTION**

Most homeowners have no idea that many times they are being

16 • WHICH WAY IS MY FOUNDATION MOVING?



# CHAPTER FIVE

## *Solutions to Settlement*



The foundation repair industry has been around for almost 50 years and comes largely from areas of the country that have wet clayey soils that dry out under houses and require leveling with a commonly used process known as underpinning.

Underpinning is the process of driving piles down through various layers of soil until the pile refuses to go any deeper when it encounters what engineers call load bearing stratum, which is really hard soil or rock. The soils in the active zone..... where water can reach the

various layers from above.....are by passed and the load of the house is transferred down to load bearing strata via the pile that is mechanically attached to the footing.

This is a reliable and effective method of stopping a foundation from sinking and even raising it back up to level it. Holes are dug at each pile location and it is driven and attached to the footing and covered up when completed. There are many manufacturers, suppliers and installers available to bring these to homeowners and most are very reliable systems.



Total overall difference from high to low in the foundation is not the most important thing.



## Solutions to Settlement

**“Underpinning is the process of driving piles down through various layers of soil until the pile refuses to go any deeper when it encounters what engineers call load bearing stratum, which is really hard soil or rock.”**

  
**CONSUMER  
ALERT**

*Don't Get  
Ripped Off!*

**Demand your repair  
plan be stamped by  
an engineer!**

**Fact: An engineer  
stamp will provide  
you confidence and  
peace of mind.**

### Preparing The Foundation Footing



For an outside installation, the soil around your foundation must be excavated to expose the footing at each pier location. For an inside installation, a section of your slab floor will need to be removed to expose the footing. The slab is restored after the installation.

A section of the footing will be cut away so that the steel bracket connected to the pier will support the wall directly. This approach will provide more effective support than lifting the section of the footing that extends beyond the walls.

Installing a helical pier system in the earth around a foundation in Scottsdale

### Installing Helical Shafts



Next, steel helical piers are turned down into the soil until competent strata is reached. Extension shafts are added as necessary to reach greater depths.

These steel foundation piers are the strongest components in our foundation repair arsenal, and are responsible for transferring the weight of your structure to solid, load-bearing soil. Our foundation piers are available with a galvanized steel design. These piers are corrosion-resistant, for long-lasting durability.

Foundation repair contractors installing the foundation bracket in Glendale.

### Installing Foundation Brackets



Unlike push piers, helical piers are driven fully and completely before their brackets are attached.

This is mainly because helical piers don't require the heavy weight of the structure to be driven into the soil. This makes them ideal for lighter structures, such as decks and concrete stairs.

Once all helical piers are installed, steel brackets are attached to connect each pier to the footing.

Foundation repair contractors lifting a structure in Mesa.

### Lifting The Foundation



Once all piers and brackets have been installed, the settlement of your foundation will be permanently halted.

At this time, one of our team of in-house foundation contractors will determine whether or not it makes sense to lift your foundation back to its original position. This operation has the potential to close cracks in your foundation and return doors, locks, and windows.

# CHAPTER SIX

## The Insider's View of the Foundation Repair Industry



***"Please Doctor, make sure you  
operate on the right leg!"***



***"The fact that there  
are so many homes  
with heave that  
go misdiagnosed  
seems to fly  
under the radar  
and not get  
much attention."***

## The Insider's View of the Foundation Repair Industry



In my previous chapter, I talked about the problem in the foundation repair industry of recognizing and dealing with expansive soils in an honest and accurate way. I discussed that the symptoms for both heave and settlement look very similar from just walking around and looking at the house. The fact that there are so many homes with heave that go misdiagnosed seems to fly under the radar and not get much attention. This is amazing considering that it is a \$55 billion a year industry in North America and much of that is wasted

on the wrong solution. In dry climates like Arizona, the number is staggeringly high. We see at least 75% of the homes that we encounter some form of heave from expansive soils.

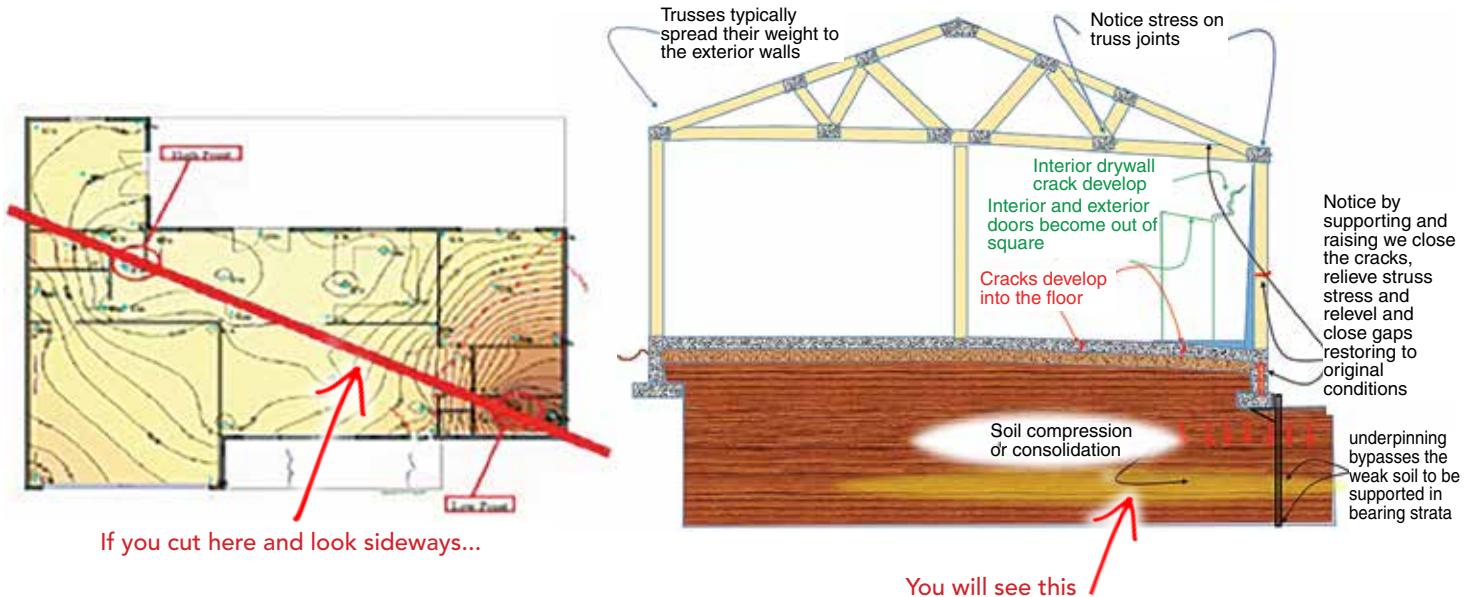
Let's look at why underpinning, the common accepted solution for settlement, is the wrong thing to do for homes that have heave from expansive soils. Take a look at the picture on the previous page.

Having no changes in moisture under your foundation is the key to stability. Make sure that no water pools beside the foundation if you are in an arid environment or stays wet if you are in a wet environment.





## The Insider's View of the Foundation Repair Industry



In my previous chapters I discussed how foundation contractors commonly mis-diagnose foundation repairs often installing piles when there has been no footing settlement, mistaking the symptoms of heave for settlement. Homeowners in the past have had little protection in this scenario. The best that we can do is provide the information so that if homeowners learn basic facts, they can protect themselves.

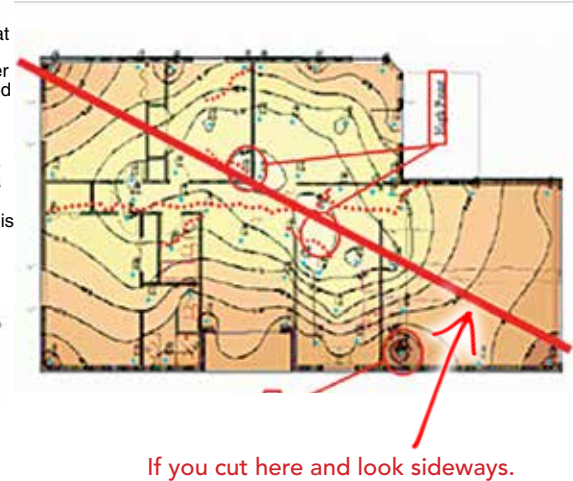
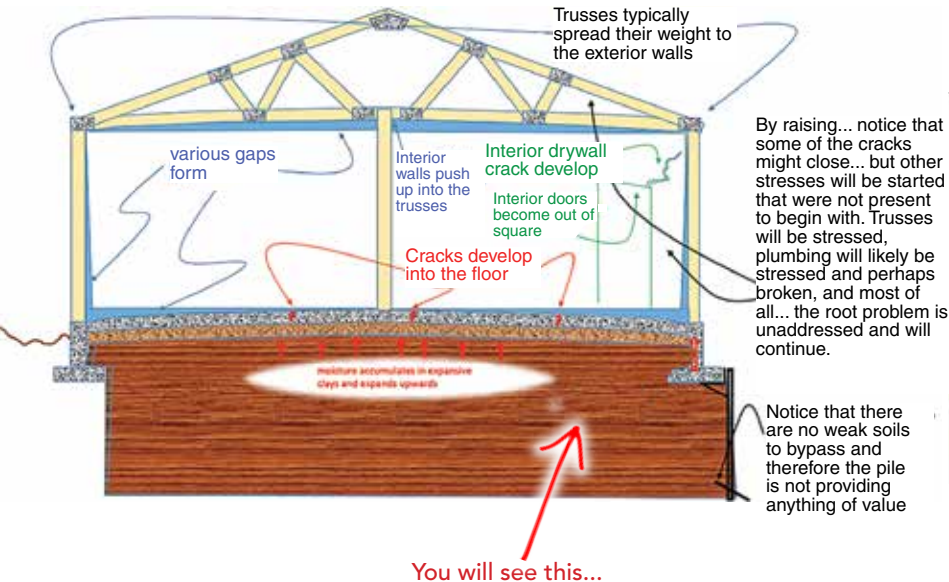
**“One of the best tools an engineer or contractor has to evaluate a foundation is the manometer or floor elevation survey.”**

One of the best tools an engineer or contractor has to evaluate a foundation is the manometer or floor elevation survey. Drawing an accurate floor plan and then mapping the elevations of the floor, you can then use computer mapping to arrive at contours. We like to map the contour lines in color so that by looking down on them it is easy to understand the higher and lower elevations. Take a look at the sample below.

In the example above, the darker colors are the lower elevations. Because the lower elevations are also accompanied with cracks in the floor and in the walls (shown as red dashed lines), we can infer that the lower areas have likely moved downward. See how that correlates with the cross section view (slicing along the red line) and looking beside it.



## The Insider's View of the Foundation Repair Industry



Notice again how the profiles match up to each other in the side by side comparisons above. We can tell what the contour section looks like by measuring the elevations along the section line.

It is not enough to know that one portion of the house is higher or lower than the other. What matters more is the profile between the two points. Next we need to discuss deflection, the profile and how it compares to the difference between the high and low points called tilt. These are 2 separate concepts that have different interpretations.

**“It is not enough to know that one portion of the house is higher or lower than the other. What matters more is the profile between the two points.”**

# CHAPTER SEVEN

## How Bad is Bad?

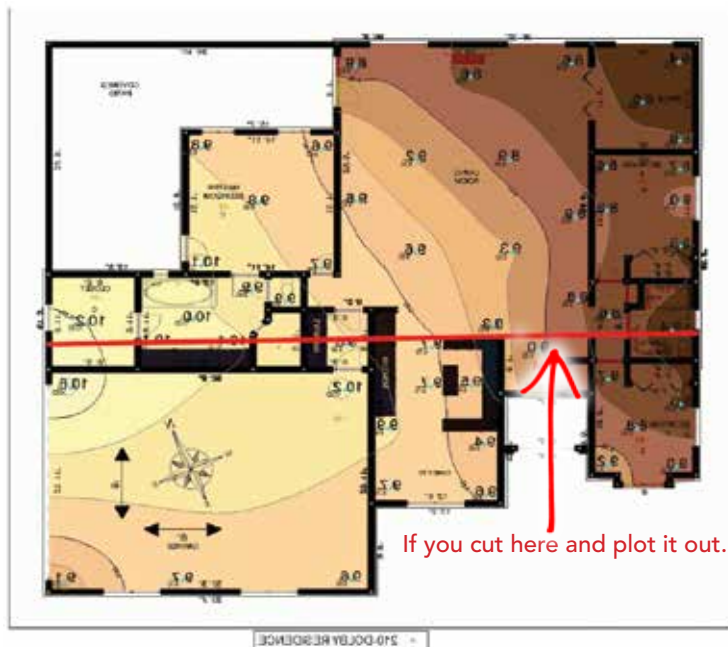
So the house is 2" lower in one area vs another. Does that mean it needs underpinning? Not necessarily. I have seen houses up to 9" out of level with very little damage and houses out of level 1" to 2" out of level with much more damage. What gives?

The house with 9" in this case had a very rigid slab and all of the elevation difference was basically just a very steady, even tilt from one side to the other. The house with a ton of damage and only 1-2 inches had a huge bulge in the profile of the footing and floor. That "bulge" is called deflection. If the bulge side is like a bow and the height of it is the string, the deflection is the difference between the bow and the string. In other words

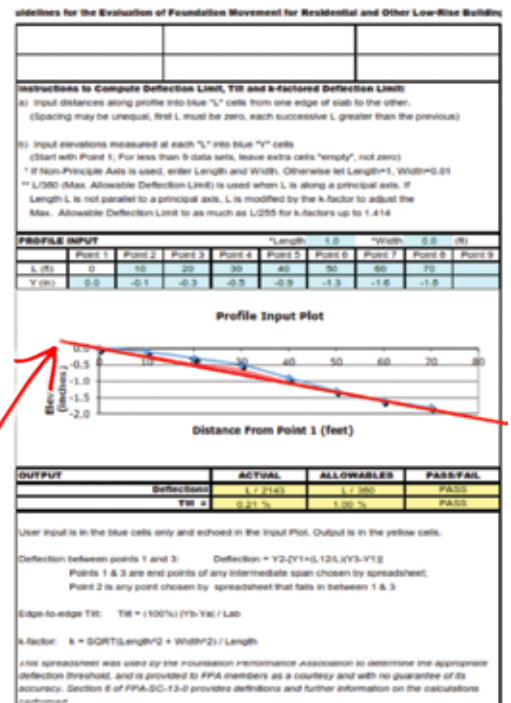
the bend in the footing/slab is what creates stress on the structure.

Take a look at the 2 profiles below. The first is tilt the second shows deflection.

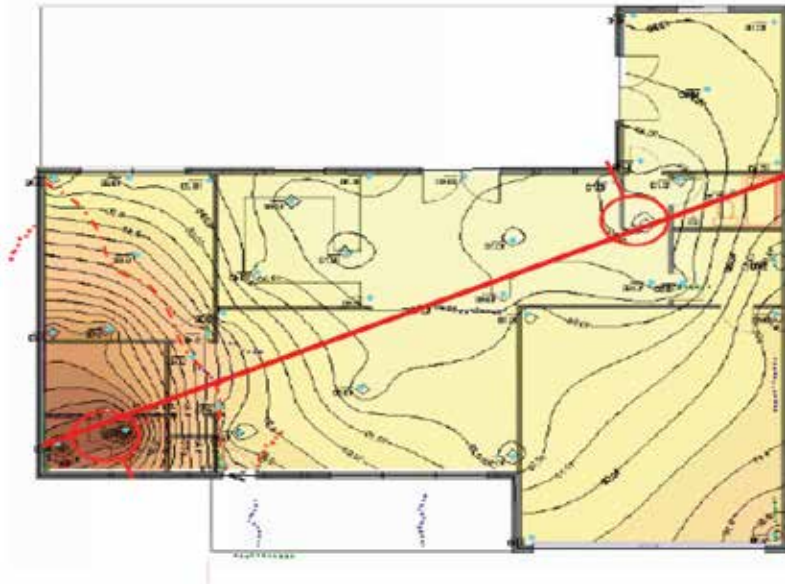
Notice how the profile shows a nice even slope from one side to the other. Also see how the actual line does not deviate from the red slope line. As you might suspect not as much damage in this house



You will see this



## How Bad is Bad?



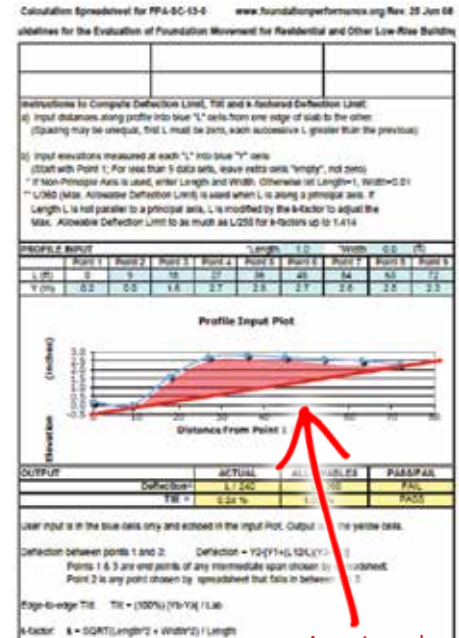
Now take a look at this one. See how there is a big difference between the red line and actual profile? This house had lots of distress and was in bad need of leveling.

Now... how can you determine deflection without having all of the points and subsequent contour lines to plot? Obviously you cannot.

How much tilt or deflection is too much? Structures can withstand a lot of tilt as compared with deflection as discussed above. The Foundation Performance Association

has developed a consensus of tilt of 1% and deflection of  $L/360$ . Accordingly I feel those guidelines should be followed unless a new and better consensus is ever developed.

So now what happens if we discover with our careful analysis that there is a floor slab heave and no footing movement? In my next chapter I will lay out the options including a revolutionary process developed by our team.



Area in red represents the deflection



**Is your contractor following industry standards or their standards?**

**Fact: You are not a foundation expert, so industry standards protocol is there to protect you, demand it!**



How to judge Severity.  
 How bad is it? Is there a scale?

# CHAPTER EIGHT

## How to Remediate a Heave



We have established that many homes have floor heave. And we have established that many homes get misdiagnosed. We have also established in my previous chapters that this is a significant occurrence.

If we have a structure with floor heave what are the real options for remediating it. They are as I see as follows:

- Cut off walls
- removal and replacement of interior slab
- grading and drainage improvements
- excavation lowering
- correction smart foundation system

### cut off walls

*This process is expensive and time-consuming. Somewhere in the neighborhood of \$45-75,000.*



Let's talk about these for a minute. We have installed many cutoff walls. They are expensive and intrusive. They involve excavating a 5 foot wide by 1 foot deep trench all around the house, followed by a deep trench 4 feet deep. A/C units, pool pumps, sidewalks, plants, irrigation, and

all underground utilities all need to be moved. Plastic is then run from the bottom of the trench and attached to the edge of the stem wall of the house. Here is a picture. It is the same picture I will use for Excavation Lowering because it also demonstrates that also.



## Removal and Replacement of Interior Slab



*This process is expensive and time-consuming. Somewhere in the neighborhood of \$100,000-\$200,000.*

Removal and replacement of the interior slab is even more expensive and more intrusive. This basically is gutting the entire interior of the house including the floors, all cabinetry, plumbing fixtures and rebuild-

ing it. The cost is somewhere in the neighborhood of \$100,000-\$200,000 and an involved moving out entirely and rebuilding and moving back. Not fun.

# This makes no \$ense!



## Gutters and Drainage Improvements



We almost always recommend grading and drainage improvements on any house that has soil issues. Depending on the scope, this can range from relatively cheap to somewhat expensive. Many times this fails to

fix the problem all on its own. Although it can help. If the slab is wetter in the middle and drier on the edges, drying the edges could actually be counterproductive.



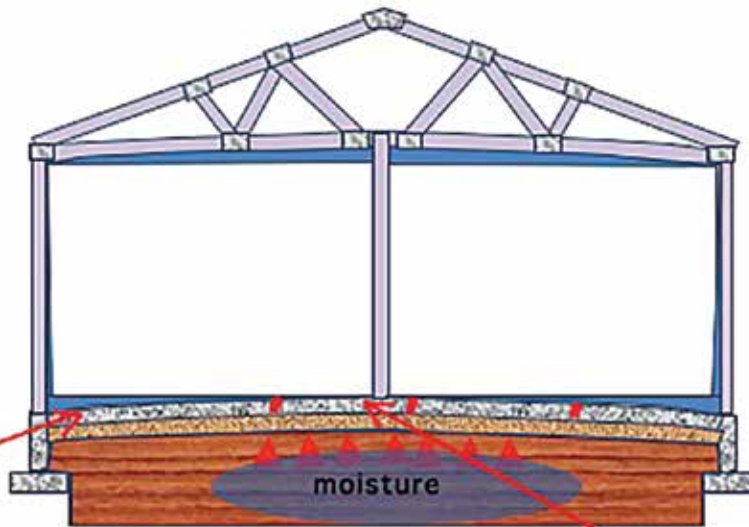
\$10,000-\$20,000.

**CAUTION CAUTION CAUTION CAUTION CAUTION**

Note: Gutters and maintaining proper drainage really has no immediate large effect on the area that is experiencing the problem.

## Gutters and Drainage Improvements

This is where gutters and drainage have their largest impact.



This is where the problem is

Recently I have heard contractors claim that gutters and drainage are a viable alternative to the moisture level system. While I have always maintained that maintaining proper drainage and limiting the moisture intrusion under a slab on houses built in the arid Southwest are a good thing and should be encouraged. We offer those techniques to customers as a method to control additional moisture getting under the slab.

What I don't agree with is that they are a viable alternative in lieu of a moisture level system, and the logic is fairly straightforward. In my blogs in the past I have illustrated how moisture accumulates under the slab over a long period of time and tends to accumulate in the middle of the slab.

The point that I want to make is that gutters and maintaining proper drainage really has no immediate large effect on the area that is experiencing the problem. That

is the place where the moisture accumulates the most, the center of the slab. See the diagram above. Notice where the problem is.... And notice the area that is affected by installing gutters drainage improvements.

What do you think the effect on the slab will be by drying the soil near the edges? If you have been following my blogs in the past you will know that as those clays dry they will shrink more. So in effect we will be increasing the differential moisture and differential elevations between the edge in the center of the slab. This is counterproductive to flattening the slab.

The moisture level system in contrast starts at the area of the most heave and where the soil has accumulated the most moisture and begins to dry from that area first working its way to the edges second. This in effect flattens the slab by reducing the heave in the area where it is highest.

## Excavation Lowering



Why don't most foundation repair contractors talk about heave remediation?

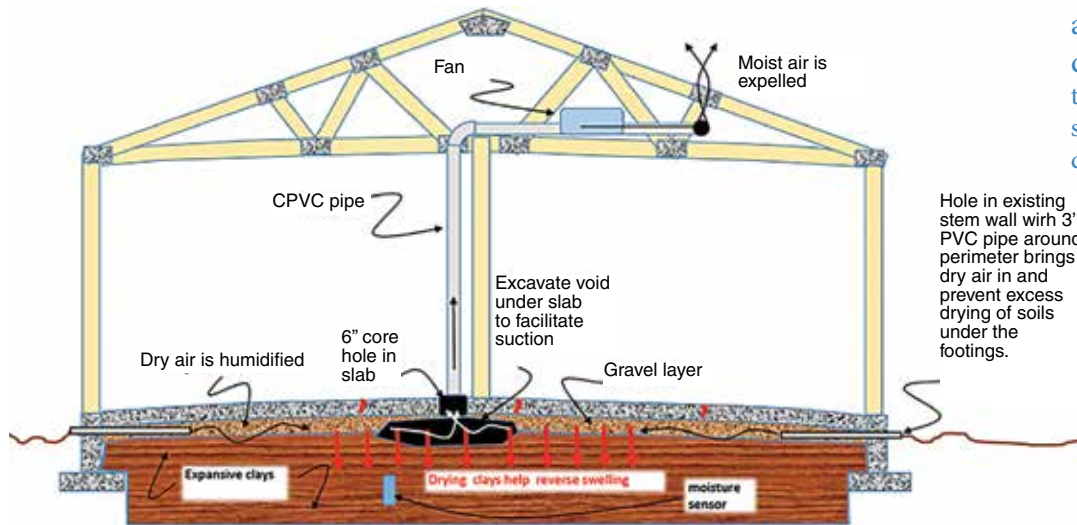
Because they have nothing to offer of practical value for it.



We have also done many excavation lowering projects over the past 10 years. I pioneered this concept and believe it is still valuable. But it is also expensive and intrusive. Somewhere in the neighborhood of \$40,000-\$150,000. It also really only works on post-tension slabs as conventional slabs don't usually

lend themselves to this kind of operation. See how the house seems to be sitting above the ground? The soil has been excavated under it... 20 feet in... sometimes all the way across. This picture also is showing the trench for the cut off wall.

# Moisture Level Smart Foundation System



act•ive soil  
de•pres•sur•i•za•tion:  
term: The act of drying the  
soil underneath a building or  
dwelling.

So that leaves us with the last option on the list. What is the MoistureLevel smart foundation system? This is a revolutionary concept that I have pioneered with local geotechnical engineer David Deatherage and the ASU geotechnical department.

13 years ago I had a discussion with Dave about a building that he helped remediate the pollution underneath it. He did this with active soil depressurization, which is another word for drying the soils underneath. The chemical removal was successful, but it had a side effect of drying out the soils and because they were clays soils, caused the building to settle. We then put our heads together and thought why we can't use this same concept to control the soils. Thus the MoistureLevel concept was born.

Below is a refined concept of how that technology works.

This is a patent pending technology that we are making available to anyone with floor slab heave. In my next chapter I will discuss the details of the system and its benefits



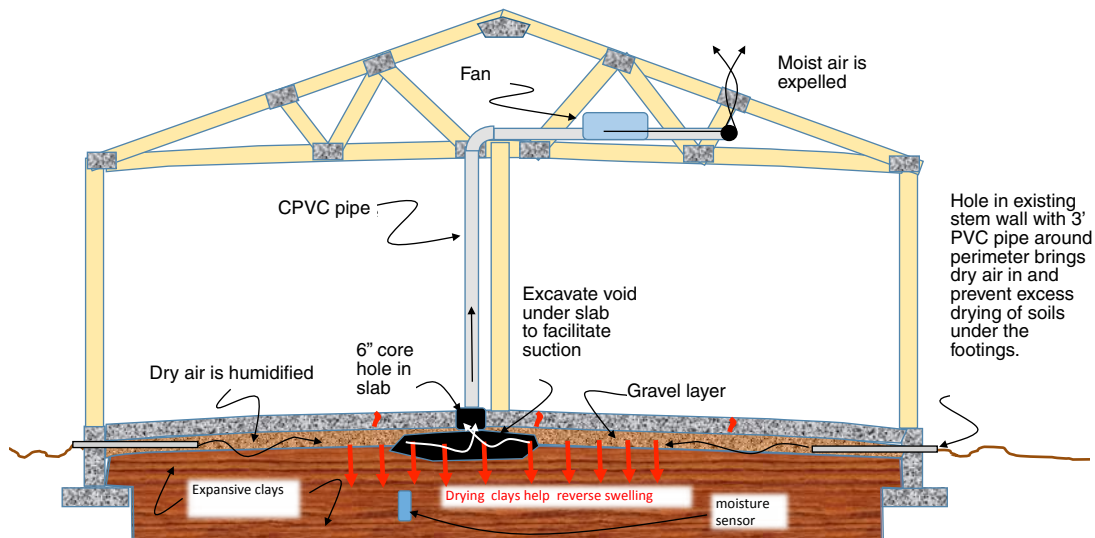


# CHAPTER NINE

## Moisture Level Smart Foundation System for Expansive Soils.



**“The idea is to use the dry air as it is forced across the soils collecting the moisture and venting it out the stack.”**



In my previous chapters I pointed out how a majority of homes and commercial properties in arid climates get misdiagnosed, and that the majority of soil related damage ends up being heave. Up until now there have been no really viable solutions for that problem..... Until now.

Many years ago I started thinking about how I can solve the seemingly intractable problem of floor slab heave. Over the years I have worked on many ideas with not much success until I returned to the idea of soil venting. Now I am pleased to say that after much long work I have developed a solution that is cost effective, efficient, and non-intrusive.

The idea is to use the dry air as it is forced across the soils collecting the moisture and venting it out the stack. As the soil becomes drier, it begins to suck the moisture out of the adjacent clays. As the clays begin to dry out they develop cracks which then dries out the soil near the crack causing it to get wider and deepen and continue to make more cracks generating a self-reinforcing cycle. Over time the clays begin to lose their moisture and cease to expand and in many cases reverse.

## Moisture Level Smart Foundation System for Expansive Soils

The system has protections to minimize any over drying near the footing area. It also has a smart mechanism that monitors the soil moisture content and regulates the drying to protect from over drying.

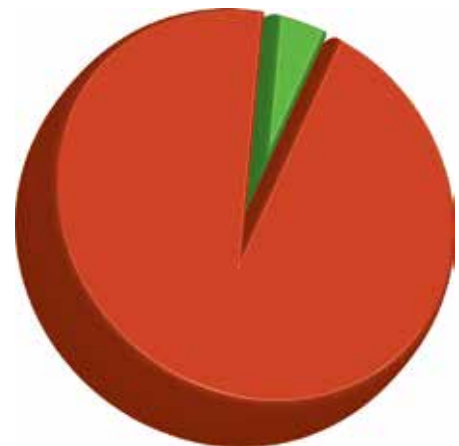
The system is easy to install usually taking less than a day. The costs are usually less than 1/20th the cost of other less effective measures of heave control and has the following benefits:

- It controls moisture of the clays under the slab in an ongoing basis providing better long term confidence in other repair type solutions

- It controls the indoor air quality for Radon (a radioactive gas) and other gases and pollutants that could be harmful that enter from the ground
- It controls the problems of wet slabs that include delaminating tile, mold and slab curling.
- There is some evidence although unconfirmed at this point that it provides some control for termites since it removes moisture under the slab



**Less than 1/20th the  
cost of other less  
effective measures...**



# CHAPTER TEN

What does it look like to install the MoistureLevel Smart Foundation System?



*This is drilling out  
the intake ports*



We have now installed about 100 of these systems in Arizona going back over a year. Here are some pictures and comments about how the installation works.

This is a process that typically takes 2 men less than a day to install. It does not require the occupants to move out, or even leave during the work. No furniture

typically needs to be moved. Here are some typical pictures of installation:

Work typically takes place in 3 areas: the first is on the outside stem wall.

## What does it look like to install the MoistureLevel Smart Foundation System?



*This is roughly  
what the end  
product looks like  
at this location:*



*The second area is in  
an interior utility or  
clothes closet:*





## What does it look like to install the MoistureLevel Smart Foundation System?

*The third area in  
usually in the attic  
or on the roof:*



# CHAPTER ELEVEN

## Why Remediate a Heaved Slab?



Once we understand what slab heave is and what causes it, the question becomes why fix it? Admittedly, it's not connected to the foundation and generally not considered a structural issue. There are a number of reasons why this should be dealt with.

The first and most obvious reason is it creates a tremendous amount of dysfunctionality in the house. This in the professional jargon is referred to as serviceability. The serviceability issues from heave are very similar to foundation settlement issues. Foundation settlement rarely creates structural instability but rather are serviceability problems. Examples are large cracks in the drywall, doors and windows that will not close properly and floors with slopes and cracks. If the Trusses start to lose their connections then under rare circumstances the structure could become unstable.

The serviceability symptoms are similar to foundation settlement, and because of that, the fear attached to floor slab heave is much greater than it should be because it is often mistaken for footing settlement. If heave conditions are not properly diagnosed,

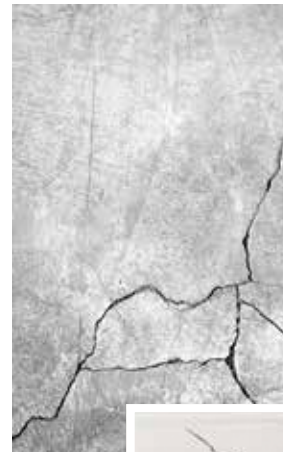
then in the sale of the house, the fear factor will greatly exaggerate their cost to remediate.

Some of the serviceability issues have direct consequences all of their own in addition to the fact that they don't function properly such as allowing pests to enter and floor covering replacement issues. I have seen cracks from heaving as much as 2-inches wide in the floor.

Many heave related problems can be prevented with proper moisture management under the slab. A good interactive system will maintain the proper moisture content and prevent clays from swelling and causing these problems. Proper documentation also helps establish the fact that the condition has been dealt with in a proactive manner that will not result in future problems.

It is our goal to address these concerns in a cost effective and proactive manner for you so that you do not

have to deal with the consequences that may be much greater in at a future date.



# CHAPTER TWELVE

## Now or Later: Pros and Cons



**“If you controlled the moisture under the slab and manage it in a proactive way, we prevent small heave from developing into a large heave.”**

If you have evidence of floor heave from expansive soils what are the pros and cons of fixing now verses later?

Firstly, most floor systems are generally not considered a structural component of the house unless it is a post-tension system. They are usually a 4-inch unreinforced slab that is not connected to the perimeter footing. Movement or cracking in the slab would not by definition be a structural issue.

Often because of the heaving of the floor slab, the interior walls of the house will crack from the movement in the floor. Modern homes utilize a truss system that distributes the weight of the roof to the perimeter walls. This means the interior walls rarely hold up any of the weight



of the roof and therefore are not part of the structural system of the house.

We can in general surmise that floor slab heaving is generally not considered a structural issue unless it pushes up so high that puts pressure on the trusses on the bottom side from the interior walls.

The question is if it is not a structural problem why bother fixing it? This is the wrong question. The question should be - is the service-

ability of the house affected? In other words does the house function properly? I would argue that cracking of the interior walls and floors along with doors that will not function are serviceability issues that need to be dealt with. No one would want to buy a house with those issues.

The second question is should we fix now or later? I would argue that the sooner gets done the more credibility we gain for the repairs is established. If we

say that the repairs were done many years ago, and we can document that the house has performed properly since then, through documentation of floor elevation surveys over time, we

**“A stitch in time saves nine.”**

**-Benjamin Franklin**

have established credibility for future buyers. If on the other hand we disclose that the repairs were done a few weeks ago, we do not have any credible evidence to support future performance other than the claims of the repair contractor.

Specifically in the case of floor heave, if you controlled the moisture under the slab and manage it in a proactive way, we prevent small heave from developing into a large heave. The MoistureLevel smart foundation system is comparatively less expensive than other alternatives, it should be used as a preventative system and avoids serviceability for future buyers and the mistaken perception of those buyers that it is a structural problem.



## Recap of the Need for Heave Mitigation

I'd like to give a quick summary of where we are at with the last few chapters.

In the chapters before I reviewed how soils work, how the different types of soil affect foundations, and the various types of foundation systems commonly found. I established the fact that most buildings built in an arid environment tend to have heaving problems instead of settlement problems, close to 75%. I also established that many (I estimate up to 50%) foundation problems



get misdiagnosed by foundation contractors and even some engineers on a regular basis. I also discussed that the typical industry repair methods for remediating misdiagnosed heave are wrong and counterproductive. The repair methods that do work are expensive impractical and are not very effective in the long run.

In subsequent chapters I showed the due diligence that is required in order to properly diagnose a failing foundation. Without going through the hard work and diligence required, mistakes are likely to happen. Of course if the analysis is being done by a commissioned sales person with an agenda, the chances of the analysis being objective, and thorough are very low..... especially

if that agenda only includes methods to fix one type of problem. If the salesmen only gets paid for providing solutions to one type of problem..... How do you think he is going to see all of those problems? If the only tool you have is a hammer, then all of your problems start looking like nails!



In my last Chapters I discussed a new revolutionary way to mitigate the effects of expansive clays on existing foundations and floor slabs. I have developed this method and patented it so that I can have something of value to offer homeowners and building owners with this difficult to resolve problem. It is a unique cost effective and non-intrusive solution that has very good initial results. In my discussions with geotechnical engineers and structural engineers for the past for 12 months I have received nothing but supportive and encouraging comments for the system. Not one naysayer.

This system is only about 5% of the costs typically charged for very intrusive and minimally effective heave mitigation treatments. Let me repeat that..... 1/20th of the costs! With far superior results! At the same time it mitigates Radon radiation caused cancers, harmful gases (VOC's and PCB's from pollution), eliminates wet slabs, and a theoretical reduction in termite infestation.





## Evidence of MoistureLevel Smart Foundation System Performance



*J David Deatherage  
PE, President, Copper  
State Engineering*

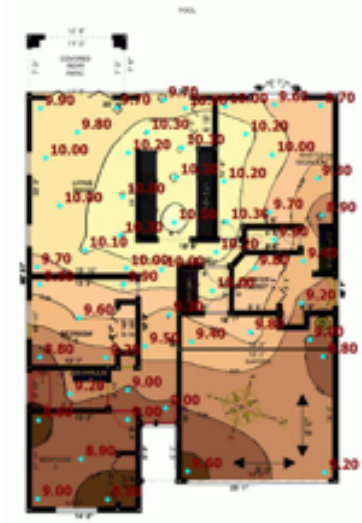
It has been 24 months since our systems install have begun (excluding our experimental work in 2003) and we have now over 200 installs to date. That is quite the response from the market place!

We have begun a robust validation and verification program in conjunction with Arizona State University and a local forensic geotechnical engineering firm Copper State Engineering. We are going back to each install after 6 months and measuring the floor elevations, the humidity of the air coming out of the system (compared with ambient outside air), its velocity exiting the system, and a few other intake air suction measurements.

While have not tabulated all of the results yet, I can say that the data is very encouraging. We have noted :

No house has increased in heave after the install with one exception. One house had an addition outside of the original stem wall

All of the houses measured have experience a either a small drop to some with up to 1/2" drop in heave.



David Deatherage PE has calculated that we are removing up to 70 lbs of water per day from under the foundation.

I do have an anecdotal story to tell of the system success.

I bought a house in 2008 near Stapley and I-60, the ground zero of expansive soil in the valley. The house had 1 ½" cracks in the floors and ceilings. I repaired the cracks cosmetically and at a later date installed the MoistureLevel system. About a 10 months ago I got a call from my tenant telling me that they could hear water running under the floor slab at a very rapid rate. By the time I located the leak and fixed it, we dumped up to 100,000 gallons of water under the slab according to SRP. So far I have had only very minor signs of movement. I will keep you posted.

As we tabulate and organize the all data that we are currently collecting I will be presenting it here for you to see.



Notice the second reading on the right is much flatter than the original readings on the left.



# Which way is my foundation moving?

A practical guide to understanding foundation repair