



Soil Issues for Residential Construction in Texas



Homeowners of Texas, Inc. (H.O.T.) is a non-profit corporation, formed in May 2008 to enhance the homebuilding industry and restore consumer trust. Our aim is to ensure that new construction and remodeling is properly engineered and then built with licensed skills and regulatory oversight to protect homeowners from the devastating effects of substandard construction.

Soil Issues for Residential Construction in Texas

We offer this document to alert builders, homeowners and policy makers of two concerns that worry us about homes built on reclaimed farm and rangeland. The first concern relates to **expansive soils** that are unsuitable for building and that cause foundation problems and threaten the structural integrity of homes. The second is **residual contamination** from industrial waste or toxic pesticides that can cause serious health problems. These two issues, discussed below, are especially troublesome because of the rapid rate of urban sprawl in our state.

To address these soil concerns without stifling economic development, our Texas Legislature proposals include soil testing and foundation engineering. Our national agenda includes repeal of the Brownfields Law (i.e. Small Business Liability Relief and Brownfields Revitalization Act).

Urbanization

Urban sprawl is a national trend where cities expand geographically into the adjacent countryside at greater growth rates than their population increases. The amount of land used for urban space increased by 47% from 1982 to 1997 while the U.S. population grew just 17%.

“With 36.8 million acres of fertile soil, Texas has more prime farmland than any other state,” according to the U.S. Department of Agriculture. At least 1.7 million acres of that farm and rangeland were converted to neighborhood developments between 1982 and 1997. Most affected was the Texas Blackland Prairie, which got its name from the fertile soils that are rich in black clay and noted for helping Texas become the nation’s top cotton growing state.

Source: “Agriculture and Urban Sprawl,” http://www.texasep.org/html/Ind/Ind_2agr_sprawl.html

Urban development of farmland, combined with access to immigrant workers, has contributed to relatively low building costs in Texas; but the lack of regulatory oversight and accountability has attracted some irresponsible builders to our state.

Foundation Problems caused by Expansive Soils

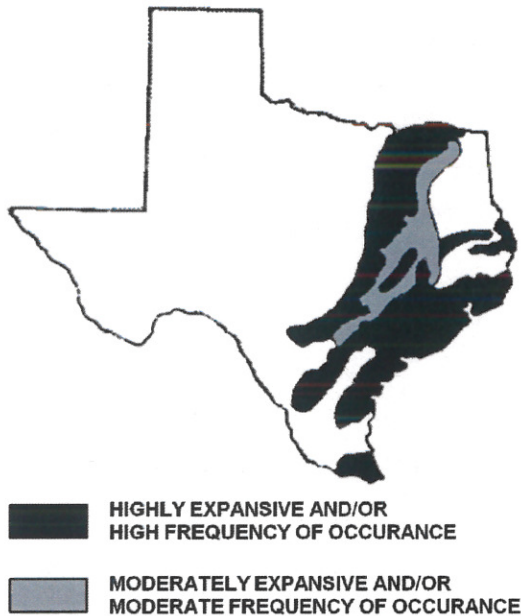
Few consumers know about the structural integrity risks of buying homes built on shifting or expansive soils. Especially troublesome are new homes built in the Blackland Prairie, a belt of fertile black clay that is bounded on the west by the Cross Timbers and Prairies Region and in the east by the Post Oak Savannah Region, extending southwesterly along Interstate-35 from the Red River to San Antonio – about 12 million acres in all. The region gets its name from the rich, black, waxy, alkaline and calciferous soil that retains water and yields highly productive farmland.

The City of Hutto, which is in the middle of the Blackland Prairie and was known for ranching and cotton farming before its recent urbanization, has recently become one of the fastest growing small cities in America, enjoying a growth rate of

about 880% between 2000 and 2005 (per Wikipedia). But it seems that Hutto land is better suited for growing crops than building homes.

The U.S. Department of Agriculture Natural Resources Conservation Service has determined that most of the land in Hutto is made up of the most expansive type of clay. According to the department, the soil is "very limited for building," with weaknesses that "generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures." This explains why so many homes in the communities of Hutto Parke and Legends of Hutto have had serious foundation problems. Widespread problems in homes built by a few volume builders who didn't take proper engineering precautions have caused these neighborhoods to rapidly decline.

EXPANSIVE SOIL AREAS



DEPTH

0'

1'

2'

3'

4'



Blackland clay has been called "nooner" soil because it's often too gummy to plow on wet mornings but can dry as hard as concrete by mid-afternoon. Even today, a brief shower can make unpaved farm roads dangerously slick or impassible, even for four-wheel drive vehicles. The reason black clay causes foundation problems is the fact that it expands greatly when wet and contracts when dry.

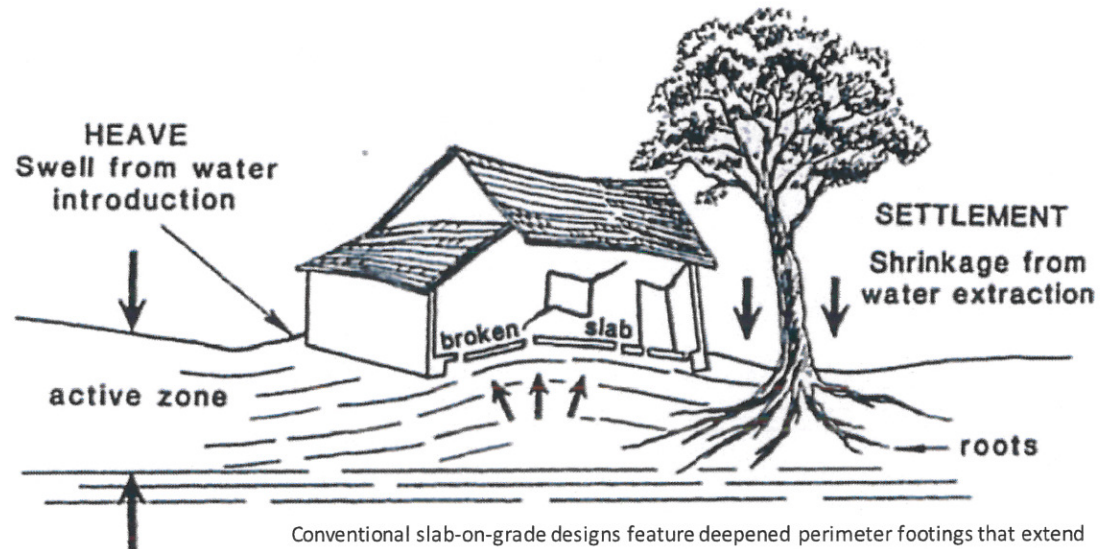
Structures at Risk

Expansive clay soil, also called shrink-swell soil, causes billions of dollars of damage in the United States each year. With the ability to expand in volume up to 30% or more when water is absorbed, expansive soils can generate tremendous pressure on structures such as concrete foundations. These pressures, which have been measured as high as 15,000 pounds per square foot, can cause foundations to heave when wet and sink when dry. Either way, damage can be extensive.

According to [Foundations in Expansive Soils](#), a document by the U.S. Department of Defense, the types of structures most often damaged by swelling soil include foundations and walls of residential buildings. "Lightly loaded one- or two-story buildings, warehouses, residences, and pavements are especially vulnerable to damage because these structures are less able to suppress the differential heave of the swelling foundation soil than heavy, multistory structures."

Government and commercial buildings in Texas are required to be engineered by professional engineers and built by licensed and bonded contractors, but residential construction is exempted from these rules. That's both foolish and irresponsible.

Center Lift of a House Foundation



Conventional slab-on-grade designs feature deepened perimeter footings that extend below the primary zone of cyclic heave and shrinkage. Concrete for the footings and interior slab is usually poured at the same time over plumbing and rebar for added strength. Posttensioned slab-on-grade designs replace rebar with steel cables that are greased and run through plastic sleeves and later tensioned with hydraulics to create rubber band like forces pulling inward on the foundation. Still, fractures can occur unless structural engineers design for specific soil conditions.

The three most common foundation designs for expansive clay are:

1. Conventional slabs-on-grade;
2. Posttensioned slab-on-grade; and
3. Pier and beam.

To ensure the long term structural integrity of Texas homes, these foundations must be designed to handle two conditions: (1) center lift (also called center heave or doming) and (2) edge lift (also called edge heave or dishing).

Type of Damages

Structural damage can result when if foundations are not designed for specific soil and environmental conditions. These damages include distortion and cracking of pavements and on-grade slabs, cracks in walls & beams, and jammed or misaligned doors & windows, among others.

- **Doming heave** is a foundation distortion that can occur over a period of years due to progressive and upward swelling beneath the center of the slab. The corresponding dome-shaped heave causes external walls to lean outward, resulting in horizontal, vertical, and diagonal wall fractures, with cracks generally wider at the top. Additional horizontal fractures can appear at the top of the wall near the roofline.
- **Edge heave** is a dish-shaped distortion that may be observed relatively soon after construction, especially if dry surface soil is suddenly exposed to water during a rainy spell or with irrigation. Localized heaving may occur near water leaks or areas of standing water.



- **Cyclic heave** relates to the expansion and contraction over time, based on changes in weather, the frequency and amount of rainfall, and even automatic sprinkler cycles.
- **Lateral movement** can cause basement and retaining walls to bulge and fracture.

Assessing Risk

Foundations must be properly engineered for different soil and environmental conditions or serious failures can occur. But soil conditions vary widely across the state, and over 100 soil types are found in Travis County alone. That's why each construction site should be tested by a geotechnical engineer to determine the plasticity index of representative soil samples.

Plasticity index is a measure of how expansive the soil is and how its characteristics change with moisture. Other factors used in assessing environmental risks include: water-table depth, climate, topology, drainage, surface irrigation, landscaping & vegetation, condensation from water lines & sewers, heat sources that cause drying, and thermo-osmosis – a process where moisture migrates from a warm zone outside of the home to a cooler zone underneath. Understanding these various factors can help structural engineers design sound foundations.

Preventing Failures

We've all heard the myth that homeowners can prevent foundation failures by watering the lawn properly and not allowing standing water to pool at the foundation. While that's good advice, it's a gross oversimplification because even the best engineers at Texas A&M can't tell us how to do that. And even with expertly programmed automatic sprinkler systems, the soil around foundations can dry out faster on the sunny side of a house than on the shaded side. So in reality, it should be the responsibility of the builder, and not the homeowner, to prevent foundation failures – by designing and building them correctly in the first place.

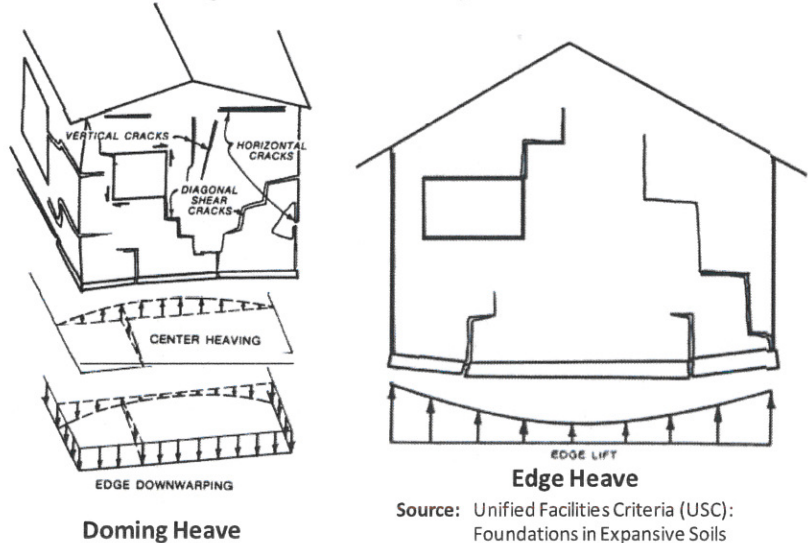
The plain truth is that it costs more to build sound homes on expansive soils. Part of the cost is for the professional skill and judgment needed. Experience also shows that the cost of repair is very much higher than the cost of a proper initial design, and the results are much less satisfactory.

An alarming number of homeowners have told horror stories with eerie similarities about their foundation problems. Most of the problems occur when Texas builders either cut corners to save money or don't understand enough Building Science to know about the stringent engineering requirements for building on expansive soils. They do know, however, that it can take years for the destructive effects of expansive soils to appear, and so do their builder-owned mortgage companies. But they're allowed to think, *"What the heck? We'll be long gone by then, and the mortgage will be sold to someone else."*

Without regulatory oversight and accountability, there's nothing in place to punish bad builders and prevent resulting problems with defective homes and foundations. To make matters worse, Texas protects builders by blocking homeowner access to courts even when serious construction defects destroy their homes and lives. A better way to minimize lawsuits is to address the cause.

Because Texas regulators have a moral duty to protect the public's health, safety and welfare, they should abolish the ineffective TRCC (Texas Residential Construction Commission) and pass new legislation to ensure that builders are qualified, licensed, insured, and held accountable. To this end, we need mandatory soil testing, strict rules for building on expansive soil, licensing, and other homeowner protections.

Wall Fracture Examples from Doming Heave and Edge Heave on Swelling Foundation Soils

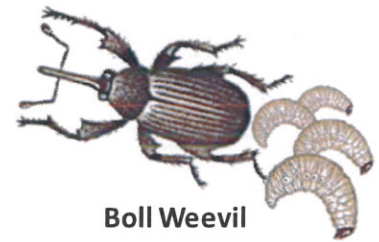


Residual Soil Contamination

Few consumers understand the health risks of buying homes built on land once used for cotton farming – land that may have residual soil contamination from pesticides. Thanks to the Brownfields Law, builders have no duty to disclose, are shielded from liability and lawsuits, and are expected to “voluntarily” clean up contamination – a step too often ignored or glossed over. That’s because the National Association of Home Builders successfully lobbied Washington under the Bush administration to promote the Small Business Liability Relief and Brownfields Revitalization Act, ostensibly to encourage development of contaminated lands. The convoluted and poorly written Act, which gives the President the authority to make determinations without judicial review, reportedly passed on a simple voice vote. So it’s clear that no responsible legislator actually read and understood it.

At least Texas requires most manufacturing industries to submit reports detailing toxic pollutants emitted into the air, water and land. But there’s far less information about the use of pesticides, which can also contaminate drinking water and endanger the health of citizens.

Arsenic is now banned for most agricultural uses in the United States, but we worry about its historical use as a pesticide, which can become a serious problem when farmland is disturbed by urbanization. Arsenic-based pesticides have been used for decades by cotton farmers to kill boll weevils and other pests. And over the years, increased pest resistance by more than 500 species of insects has led to increased application, combining pesticides, and substituting more toxic chemicals to maintain the same level of pest control. The residual pesticide contaminates the soil.



Boll Weevil

Pesticides are not only toxic to weeds and bugs but also to humans. Whether or not an individual is affected, however, depends on factors such as exposure levels (dose and duration), age, sex, size & weight, diet, family traits and state of health. Documented health effects from pesticide exposure include different types of cancer, birth defects, reproductive abnormalities, hormone disruption, immune system disorders, neurological problems and other nervous system impairments.

Arsenic (**As** on the Periodic Table) is a notoriously poisonous chemical element that was used for centuries to discreetly murder rivals, thus earning a reputation as the *Poison of Kings* and the *King of Poisons*. Texas cotton farmers used arsenic to kill their rival, the boll weevil. They also used it, at higher concentration, as a defoliant to make cotton picking easier.

Yes, it’s true that arsenic is commonly found in nature but not in the dangerous concentrations discovered recently in City of Hutto neighborhoods. The form of arsenic found in nature is usually combined with other elements such as oxygen, chlorine and sulfur. In that form, called inorganic arsenic, it’s less harmful than the organic arsenic used in pesticides.

Pesticide Exposure

You can be exposed to by eating food, drinking water, breathing air, or digging in the garden. Children are especially susceptible to the effects because of their size, amount of time they spend outside, their hygiene, and their habit of putting hands or fingers in their mouth or intentionally eating dirt. Their relatively small size means children eat, drink and breathe more per body weight than adults. Small children can also come in contact with pesticides by crawling on carpets contaminated with pesticides that parents track in.

Resolving the serious health concerns of homebuilding on contaminated soils will require both state and national initiatives. Texas officials need to require soil testing. And the U.S. Congress needs to repeal the Brownfields Law.