A Guide to Expansive Soil and a Few Suggestions on How to Minimize its Effects

What is Expansive Soil?

The underlying clay soils found in this area are, in many instances, generally classified as "expansive." This means that a given amount of clay will tend to expand (increase in volume) as it absorbs water and it will shrink (lessen in volume) as water is drawn away.

What are the Effects of Expansive Soils?

The effects can be dramatic if expansive soils supporting structures are allowed to become too wet or too dry.

Patios, driveways and walkways may crack and heave as the underlying expansive soils become wet and swell. Sometimes the cracking and heaving appear temporary as the soils dry and shrink back to their original position.

However, footings can behave differently. The concentrated weight of the structure will inhibit the soil's upward expansion. Outward expansion on the other hand may continue. The footings will not be returned to their original position as the soils dry and shrink. Instead, they can "ooze" down to a slightly lower level. This process can accumulate if the wetting and drying is allowed to continue season after season, year after year.

- Original Construction

  Foundation with load embedded in expansive soil at low to medium moisture content.

- "Wet Behavior" - Lateral Soil Migration

  Lateral migration of soil particles occur as a result of lateral confining pressures being lower than vertical confining pressure by foundation.

- "Dry Cycle Behavior" - Foundation Settlement

  Progressive settlement occurs with successive wet and dry cycles.

Damage is most noticeable if the footings "ooze" at varying rates under different areas of the structure. Cracks may appear, windows and doors may stick and floors may slope as the footings become progressively more out of level.

This differential can be caused by improper drainage, plumbing leaks, and even thirsty trees. (Please see the following section.)

What Can I Do to Minimize the Effects of Expansive Soil?

Some movement, resulting in hairline cracks, is likely to occur in houses built on expansive soils. However, a homeowner can minimize cracking and possibly prevent major damage by judicious attention to maintenance constant and acceptable moisture levels completely around the structure. Following are a few simple suggestions that might help.

1. Roof Drainage - Install rain gutters with downspouts that drain to the street via non-erodible surfaces.
2. Planter and Yard Drainage - All areas should drain to the street. Even puddles are potential problems.
3. Concrete and Asphalt Areas - These also should drain to the street. Where possible, concrete and asphalt should flow to a yard or planter area.
4. Subsurface Drainage - Install drains if necessary to eliminate ponding. Maintain all lines clean and free-flowing. Drain lines should discharge at the street.
5. Repair Plumbing Leaks - Monitor consumption. An unexplained increase your water bill could indicate a leak. Repair immediately.
6. Landscaping - Plan carefully. Trees, small ones, can draw huge amounts of from nearby soils. They should not be planted close to structures.
7. Watering - Year-round watering should be planned to avoid too much moisture in the rainy season and too little in the dry season. Automatic watering systems may help, but they can require a seasonal adjustment and attention to maintenance. If the valve accidentally sticks open, major damage could result.

DAMAGE TO FOUNDATIONS FROM EXPANSIVE SOILS

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Expansive soils in many parts of the United States pose a significant hazard to foundations for light buildings. Swelling clays derived from residual soils can exert uplift pressures of as much as 5,500 PSF, which can do considerable damage to lightly-loaded wood-frame structures. Insurance companies pay out millions of dollars yearly to repair homes distressed by expansive soils.

Expansive soils owe their characteristics to the presence of swelling clay minerals. As they get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. Swelling clays can control the behavior of virtually any type of soil if the percentage of clay is more than about 5 percent by weight. Soils with smectite clay minerals, such as montmorillonite, exhibit the most profound swelling properties.

Potentially expansive soils can typically be recognized in the lab by their plastic properties. Inorganic clays of high plasticity, generally those with liquid limits exceeding 50 percent and plasticity index over 30, usually have high inherent swelling capacity. Expansion of soils can also be measured in the lab directly, by immersing a remolded soil sample and measuring its volume change.

In the field, expansive clay soils can be easily recognized in the dry season by the deep cracks, in roughly polygonal patterns, in the ground surface (see Fig. 1). The zone of seasonal moisture content fluctuation can extend from three to forty feet deep (see Fig. 2). This creates cyclic shrink/swell behavior in the upper portion of the soil column, and cracks can extend to much greater depths than imagined by most engineers.

Foundation Damage

The most obvious way in which expansive soils can damage foundations is by uplift as they swell with moisture increases. Swelling soils lift up and crack lightly-loaded, continuous strip footings, and frequently cause distress in floor slabs.

Because of the different building loads on different portions of a structure's foundation, the resultant uplift will vary in different areas. As shown in Fig. 3, the exterior corners of a uniformly-loaded rectangular slab foundation will only exert about one-fourth of the normal pressure on a swelling soil of that exerted at the central portion of the slab. As a result, the corners tend to be lifted up relative to the central portion. This phenomenon can be exacerbated by moisture differentials within soils at the edge of the slab. Such differential movement of the foundation can also cause distress to the framing of a structure.

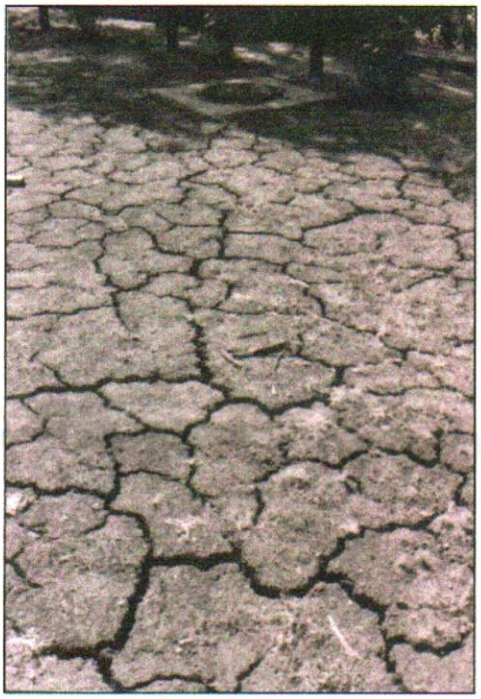

Figure 1: *Polygonal pattern of surface cracks in the dry season. These cracks are approximately one inch wide at the top. Note sewer manhole in background.*

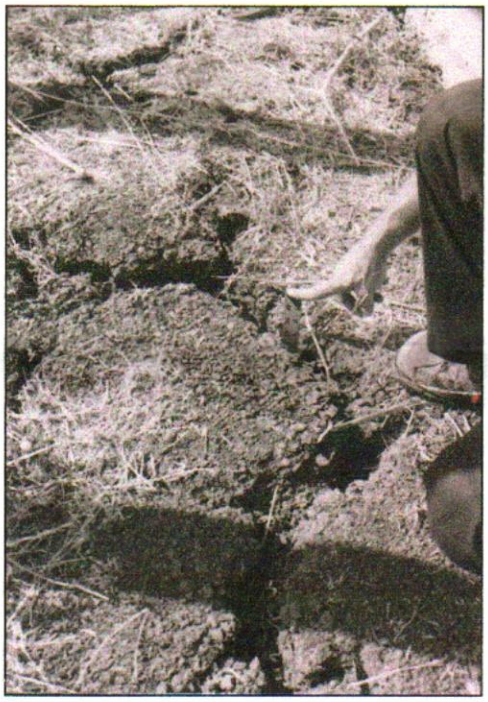

Figure 2: *This crack is at least 32 inches deep. The yardstick was easily inserted to this depth; narrower, less straight cracks may extend much deeper.*