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By Richard Hammerberg, PE

Beating thirsty dirt

A Texas city requires developers to test soil for water content before designing and building roads.

For years, streets and roads in the Dallas suburb of Frisco, Texas, have been failing at unusually high rates—sometimes in less than two years—causing maintenance and reconstruction costs to exceed budget allowances.

Part of the failure is from increased traffic generated by the city's explosive growth, from 34,000 residents in 2000 to more than 92,000 today. But another reason is that roads weren't built to accommodate the city's unusual soil.

Texas is one of a handful of states that has "expansive" soil. Also known as swelling soils, expansive soils contain minerals—usually clay—that absorb water. Such soil can swell up to 15 times its original size, causing severe damage to pavement. Though most prevalent in California, Colorado, Illinois, Kansas, Louisiana, Missouri, Montana, Nevada, South Dakota, Texas, and Wyoming, expansive soils are present throughout the nation.

To minimize the soil's tendency to expand and contract, Frisco—like many cities in Texas—requires builders to add lime to road subgrades. Lime breaks clay down so it's less susceptible to heaving and shrinkage. With enough lime, the clay fully stabilizes and subgrades last much longer.

When there isn't enough lime to fully stabilize the subgrade, over time—sometimes as quickly as within six months—the lime turns into calcium carbonate and the clay reverts to its original thirsty state.

To ensure new roads are built with the proper subgrade, the city enlisted the help of CTL | Thompson Inc., a Dallas-based consulting firm that specializes in geotechnical, materials, and environmental engineering and testing. In the late 1980s, CTL developed a formula to minimize expansion and contraction on 5.5 million square yards of pavement at the Denver International Airport in Colorado (another state rife with expansive soils). So far, none of those runways, taxiways, or aprons has required more than routine maintenance.

In 2004, Frisco retained CTL to develop a similar formula based on its soil's composition, and to help write an ordinance that would force developers to design longer-lasting subgrades.

The new protocol was approved in March 2006 with the support of the Frisco Developers Council and has been applied to new street construction projects begun in Eagle Ford, a rapidly expanding area of the city that sits on a shale formation.

In essence, developers must determine the subgrade's potential for swelling and submit a pavement design that incorporates moisture treatment. The results must be approved in writing by the city's engineering services director or designee before construction can begin.

The ordinance outlines two methods for testing the soil's expansive capabilities:

Swell testing averages soil samples from 0 to 10 feet below finished subgrade using ASTM standard D4546 at 200 psf stress, or

Potential vertical rise, where samples are taken from at least 20 feet below finished subgrade to determine the potential for swelling.

A lime stabilization design is also required to achieve a subgrade with a pH of 12.4, compressive strength of at least 160 psi, and less than 1% swell. For more detail, go to www.ci.frisco.tx.us. **PW**

—Hammerberg is president of Dallas-based CTL | Thompson Inc.

Frisco, Texas, engineers thought excessive amounts of the mineral ettringite in the city's soil was distressing roads and streets. After retaining a consulting firm to test the soil, however, they learned that the culprit is clay, which soaks up water and can expand up to 15 times its original size. Photo: CTL | Thompson Inc.