

FOCUS DEVELOPMENT

WHEN THE EARTH MOVES: Ground modification for expansive soils

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Expansive soils and sedimentary bedrock, collectively called “expansive soils,” are prevalent below much of the Front Range. Clay in the soil attracts water and will expand and contract depending on the amount of moisture being introduced or removed from the soil.

Moisture reaches the soil in many ways. Irrigation and covering the soil – with buildings and pavement – often result in water being trapped in the soil. If not controlled, this can result in “heave” potentially causing damage to building foundations and surrounding parking lots, streets, sidewalks, etc.

In the past 10 years, ground modification has been used to mitigate the problem for commercial and residential construction. Two techniques are successful – deep sub-excavation and moisture injection. Both moisten the clay soils prior to building, causing them to expand prior to construction of structures.

Sub-excavation has been used for many years to improve performance of building floors for retail, office, commercial and industrial facilities. Typically it involves excavating 3 to 5 feet (or more) of soil and replacing them with non-expansive imported sand soils or with a combination of sands and clays placed at high moisture to control swell. More recently, deep sub-excavation (10 to 20 feet) has been used to mitigate highly expansive soils, with the goal to improve performance of foundations, floors, parking lots, streets and other improvements. The expansive soils are mixed with water, and compacted in thin layers. A time consuming process, the goal is to separate the foundation from the native expansive soil or bedrock. Once filled, geotechnical engineers such as CTL | Thompson, need to observe and test the ground to ensure a safe area for development.

CTL | Thompson (CTL) has been leading the

research with deep sub-excavation for the last 10 years.

In 1993, CTL recommended deep sub-excavation for a large housing project in Golden underlain by expansive bedrock. This site was excavated to about 16 to 17 feet, and the native soils and bedrock were used as fill. The developer/builder has reported no foundation performance problems related to the sub-excavation.

In 1994, Jefferson County formed a task force to address the unusual geologic conditions in part of the County. In this area, steeply dipping, expansive bedrock, formerly resulted in a high frequency of failures of streets, foundations, floors, homes, buildings, etc. CTL contributed expertise to the group of consulting engineers, geologists, homebuilders, developers, realtors, building officials, planners and municipal engineers. As in the case in Golden, the primary mitigation technique selected by the Task Force was deep sub-excavation, involving excavation to 10 feet or more below building excavation levels.

At a project developed by Skyland Meadows Development in the Ken Caryl Ranch area, we are monitoring a deep sub-excavation site where grading was completed in 1998. The monitoring includes surveying of curb and gutter to check for vertical movement, and measurement of fill moisture in probes installed in test holes. The results are promising. Data from these projects indicate very little movement in structures and moisture measurements show that the soil has maintained its moisture. This data confirms what builders and developers have reported for other sites where deep sub-excavation has been used - better performance of the built structures.

The use of deep sub-excavation has expanded to other areas of the Front Range where highly expansive soils are found. The successful projects indicate that if deep sub-excavation is needed, it should be performed 15 to 20 feet

below final grades for residential projects. That being said, depth should be evaluated on a case-by-case basis considering the structures planned, geotechnical and geologic conditions, depth of potential moisture change, depth of ground water and calculated potential heave. Excavation should extend below the entire building footprint.

The second approach to ground modification is called moisture injection. This technique has been used successfully in Texas and nearby states for 30 or more years but has just recently become available here along the Front Range. If conditions are right and the developer is willing to try a new technique, moisture injection can be less expensive but just as successful as sub-excavation.

Done by pushing steel rods into the ground and injecting water - or a combination of water and chemicals - into the soil, moisture injection is capable of penetrating about 15 to 17 feet deep into the soil. The contractor makes several passes across a site, so when complete, holes have been injected throughout the building pad.



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WHEN THE EARTH MOVES: (cont.)



Subexcavation and moisture injection are two techniques used to reduce the effects of expansive soils.

Two variables must be considered when determining which mitigation technique – sub-excavation or moisture injection – should be used on a site. Moisture injection is only a viable option if the site is deep clay or sand. The equipment will not penetrate shallow bedrock. Additionally, timing and scale must be considered. Sub-excavation can be entirely completed prior to the start of the project. Moisture injection covers less ground and is more time sensitive. So on a housing project, for instance, 80-100 lots could be sub-excavated prior to the start of the project. If using moisture injection, three to four lots would be mitigated just prior to construction, equipment is brought back when the builder starts the next phase of lots.

With Colorado's growth, sites still available for development in the Front Range area are at risk of damaging movement. Ground modification such as deep sub-excavation and moisture injection can reduce risk on these sites. With these ground modification techniques, builders, developers and their consulting geologists and geotechnical engineers such as CTL | Thompson are striving to reduce short-term damage and long-term maintenance for future owners.



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