

TECHNICAL NOTE NO. 1.6.4

Rigid Inclusion Design Approach in Under-Consolidated Soils

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Soils that are experiencing on-going consolidation settlements during rigid inclusion (RI) present potential risk to a project. This Technical Note discusses this risk and provides the appropriate design approach.

Sources of Under-Consolidated Soils

Under-consolidated soils are soils that have not finished primary (virgin) consolidation. The two primary reasons for this behavior are as follows:

- A recent, permanent lowering of the groundwater;
- Recent fill placement in which the soil has not finished consolidating. This can include situations in which fill is added to achieve a working grade and not allowed to finish consolidating prior to RI installation.

In addition to the above, landfill/rubbish fill and heavily organic soils can often exhibit a significant amount of secondary consolidation that may resemble the behavior of under-consolidated soils. These types of soils are to be considered applicable to the design direction herein.

Note that this Technical Note does not include normally consolidated profiles in which the RIs are installed prior to fill placement. Standard RI design direction covered in the RI-related Technical Notes is to be followed.

Effects of Under-Consolidated Soils

Under-consolidated soils will consolidate after installation of the RI elements as the pore pressures continue to dissipate. As this occurs, the consolidating soil layer(s) will settle. The settling has the potential to impose additional downdrag loads on the RI elements (refer to TN 1.6.3). In addition, the settling soils will result in a net downward movement of the profile. This can result in unacceptable levels of structure settlement and/or unacceptable structural performance depending on the layering of the profile, spacing of the RI elements, and/or the amount of fill that will be placed above the RI elements.

Design Direction for Under-Consolidated Soil Profiles

The designer must account for the effects of both downdrag and settlement when designing RI support in under-consolidated soil profiles. Depending on the layering of the profile, spacing of the RI elements, and/or the amount of fill that will be placed above the RI elements various levels of analysis may be required. In some cases, utilizing a

downdrag approach as discussed in TN 1.6.3 may be appropriate with a $k_m=0$ analysis (refer to TN 5.6.1) whereas other cases may require a finite element analysis that directly models the consolidating soils. Please discuss all projects in which the soil profile is or will be (through fill placement) under-consolidated with the Geopier Area Manager to develop the correct design approach.