DO'S & DON'T'S FOR GEOTECHNICAL INVESTIGATION IN APPALACHIAN KARST

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PRINCIPLE TYPES OF “KARST”

- Recent, sandy and coralline carbonates of Florida and the Caribbean.
- Hard, but flat-lying carbonates of the central U.S.
- Hard, but folded and faulted (and some metamorphosed) carbonates of the eastern & western U.S.
WHAT DOES APPLACHIAN KARST LOOK LIKE?
YOU SHOULDN’T BUILD...

UNLESS YOU KNOW WHAT’S UNDERNEATH
Failure Modes In Appalachian Karst

LESS COMMON

MORE COMMON

SOIL VOID

SOIL ARCH

SOIL-FILLED SEAMS

WEATHERED ROCK

FRACTURES
**GEOTECHNICAL CONCERNS**

- Highly variable bedrock surface with soft soils and/or voids right on top of the rock can lead to differential settlement problems.
- Voids within the rock and overburden need to be considered in design to avoid foundation support failures.
- Highly variable properties of “bent” rock and surficial soils can cause support concerns.
- Vertical differences in the bedrock surface of 50 feet or more have been experienced over a horizontal distance of 10 feet.
GEOHYDROLOGICAL CONCERNS

• Surface water follows solution-enhanced joints, fractures, faults and shear zones.
• Fracture orientation in relation to in-situ stress orientation can allow deeper fracture penetration, thus increasing the likelihood of deeper solutioned channels.
• Ground water movement in karst usually does not behave like isotropic, anisotropic or slab-fissured/fractured rock aquifers. Can behave like a pipe (conduit) or channel flow.
• Contaminants can travel great distances undiluted and unfiltered creating a great concern for water supply wells.
• Appropriate well head and aquifer protection needed.
• Dye trace studies, where they work, are often necessary to characterize flow within solutioned carbonate aquifers.
• Currently, some sinkholes are used to control surface water flows.
Whether doing…

1. Pre-site selections studies,
2. Site evaluation, or
3. Failure evaluation,

The concepts are generally similar.
Solution Concepts

• Solutions require knowledge/experience in engineering geology, rock mechanics, soil mechanics, hydrogeology/geohydrology, and geophysics (i.e. a multi-disciplined team approach to investigation, evaluation, design and remediation).

• Nature of the project.

• Knowledge/understanding of karst by the owner’s design team.

• Funding.
Investigative Tools

• Available information for the locale of interest.
• Experience with the soil and rock types of the locale of interest.
• Direct Investigation (drilling, test pits, probes).
• Indirect (geophysics).
• Dye Tracing.
Glacial Terrain or Karst Terrane?

Kettle Holes or Sinkholes?
“Bent” Karst

• Aerial Imagery
• On-Site Mapping
• Local Quarries and Rock Cuts
• Resistivity
• Seismic Reflection/Refraction?

• EM Profiling
• Gravity
• Test Pits
• Test Borings
• VLF?
• GPR?
• Use a split, double-tube core barrel for rock sampling. Allows determination of fracture orientation, angle and often recovers void filling.
• Monitor water/air loss quantities and depths.
• Monitor grout-take quantities and depths.
Effectiveness And Utility Of Geophysics In Karst

• Variable
• Young karst – generally good
• Flat karst – generally good
• Bent karst – generally poor, but can work
2-DIMENSIONAL RESISTIVITY
**Do’s**

- Do a karst site study in phases.
- Do use the available information with a site reconnaissance.
- Do develop a preliminary geologic model.
- Do refine the model as site specific data is developed.
- Do consider geophysics as a tool.

**Don’ts**

- Don’t expect to accomplish an economical & comprehensive karst site study in a single step.
- Don’t assume that the available information accurately portrays a particular site.
- Don’t assume your model is inflexible.
- Don’t ignore the value of direct testing.
- Don’t interpret the geophysical data without hard data and experience.
**Do’s**

- Do consider resolution and technique when using geophysics.
- Do consider the value of remedial grouting as an interpretive tool for the geologic model developed.
- Do consider other remedial measures such as dynamic destruction.

**Don’ts**

- Don’t assume geophysics or direct testing has shown you everything.
- Don’t ignore overburden properties and geologic orientation when choosing a grouting technique.
- Don’t forget to inspect open excavations during construction.
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