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WHITE PAPER

WHEN DOES IT MAKE SENSE TO USE CONTROLLED MODULUS COLUMN (CMC)® RIGID INCLUSIONS?

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INTRODUCTION The available solutions for poor ground conditions are as varied as the ground conditions we encounter. While there are general categories the solutions may be grouped in, the proprietary techniques and trademarked names present additional layers of selection for the geotechnical consultant. The current state of the practice is for the geotechnical consultant to identify when ground improvement is necessary and what type of ground improvement would be appropriate. Some consultants will go further by calling out a trademark or proprietary name as a general reference, not an exclusionary list, which in turn may unintentionally limit the contractor's or owner's pricing options resulting in a higher cost to the purchaser.

BACKGROUND When the consultant is considering options for ground improvement, the technique selected can be categorized in one of three categories (see Fig 1): consolidate, densify or stiffen/strengthen.

The first two are relatively unencumbered by commercial interests. Consolidation of fine grained soils using surcharge and/or wick drains and densification of coarse grained soils using impact or vibratory energy can be selected generically. The third solution of stiffening the soil introduces many proprietary interests.

Ground improvement by stiffening can be somewhat of a misnomer. By the introduction of rigid or semi-rigid elements to improve the bearing capacity, the technique generally does not improve the strength parameters of the in situ soil. It may improve the strength parameters, but it is usually the zone immediately adjacent to the element with limited impact to the design. It is the interaction of the element with the surrounding soil that the proprietary designs take into account.

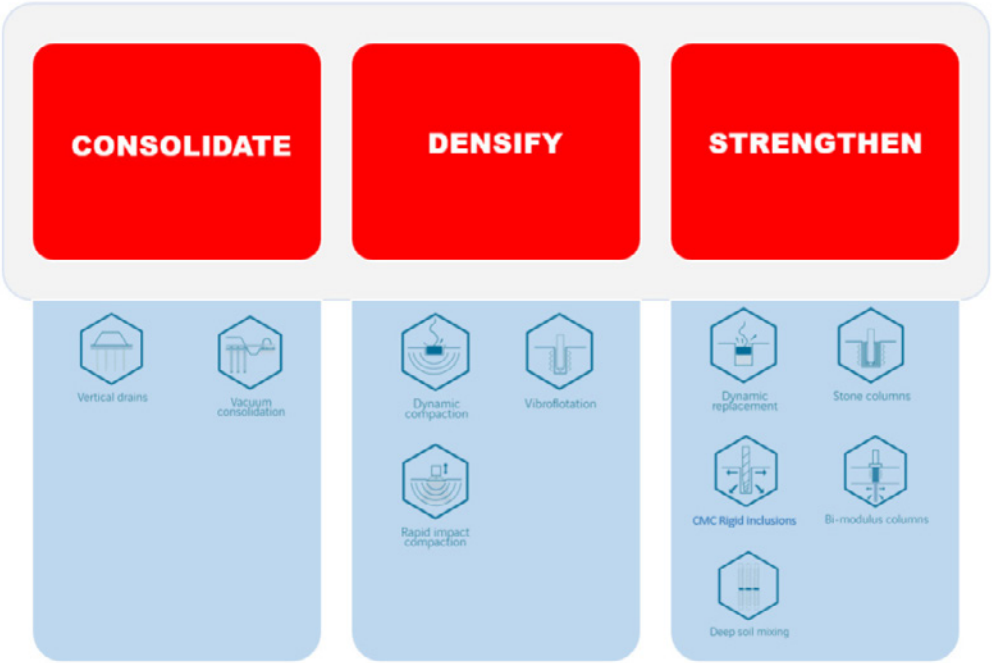

Fig 1: *The Three Types of Ground Improvement Solutions*

Selection of either a rigid or semi-rigid element is not always necessary. In many instances, either will provide the required support. The element that is ultimately used will be determined by which proprietary method is more efficient and presumably, lower cost. However, when soil conditions are weakest or are very deep, the use of rigid elements is necessary.

Rigid elements, commonly known as Controlled Modulus Column (CMC)® rigid inclusions, perform very well in soil conditions that semi-rigid inclusions, commonly known as aggregate piers (or stone columns), cannot. When N-values fall below 2, when organic material is present, or if bearing pressures are very high, the consultant needs to consider that aggregate piers require a high degree of confining pressure both to be constructible and to perform correctly. A single blow count below 2 may not be an issue if the zone is less than 3 feet thick or so. Different subcontractors will have different criteria for when soils are too soft to be improved with stone columns or aggregate piers.

Also of concern is when the soft soils are deeper than the practical installation depth of aggregate piers. The limitation of un-cemented aggregate piers is on the order of 25 or 30 feet. This will also vary by subcontractor methods, installation equipment, and design approaches. Soil mix columns can be installed in very soft soils and to depths greater than those of aggregate piers. However, the cost of soil mix columns – especially for

vertical support projects – typically exceeds the costs of aggregate piers or CMC rigid inclusions.

Once N-values are too low or the soft soil layers are too deep, CMC rigid inclusions are a perfect solution before jumping to the higher cost of deep foundations such as driven piles or drilled shafts. CMC rigid inclusions are a step before deep foundations because they are still considered a ground improvement system by utilizing the contributing stiffness of the in situ soil whereas it is neglected by deep foundations.

CMC rigid inclusions typically require the use of a load transfer platform (LTP) constructed out of granular structural fill. The LTP distributes the load from the structure into the CMC rigid inclusion improved ground, allowing a sharing of load between the highly rigid columns and the soil in between to provide allowable bearing pressures up to 8 ksf.

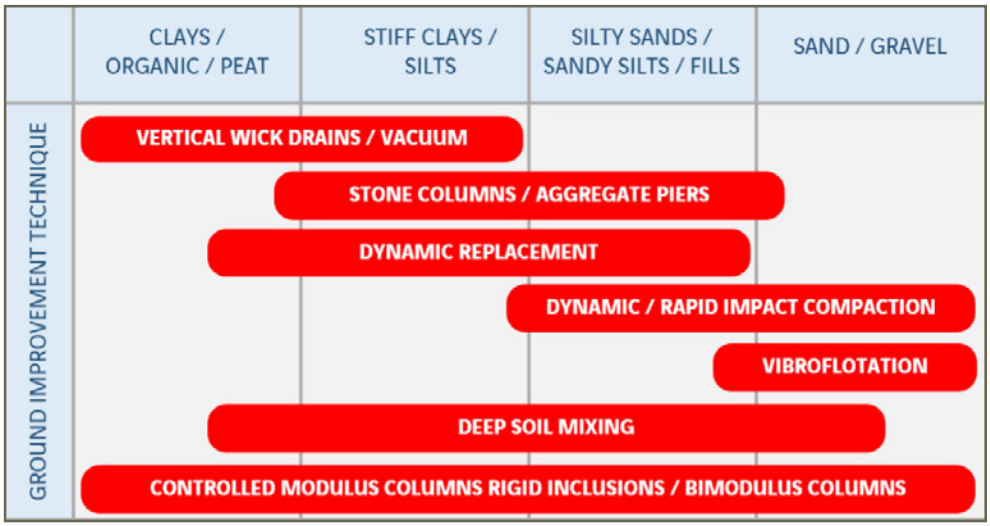

Fig 2: *Typical Range of Application of Various Ground Improvement Techniques*

CONCLUSION Menard's CMC rigid inclusions offer their greatest advantage at sites with very soft soils, poor soil conditions that extend to a significant depth (in excess of 100 feet deep), and projects with heavily loaded structures. Finally, because the installation is with displacement tooling and only minimal spoils are generated, CMC rigid inclusions offer benefits at contaminated sites.

GOING FORWARD: Do you have a project that you think would be a good candidate for a CMC rigid inclusions?

Get in touch with Menard today at **412-620-6000** or visit us at **www.menardusa.com** today to find your local Menard representative and sign up for our newsletter, The Column.

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