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WHITE PAPER

**CONTROLLED MODULUS COLUMN (CMC)[®]
RIGID INCLUSION SUPPORT FOR MULTI-
STORY STRUCTURES**

CONTROLLED MODULUS COLUMN (CMC)[®] RIGID INCLUSION SUPPORT FOR MULTI-STORY STRUCTURES

INTRODUCTION Controlled Modulus Column (CMC)[®] rigid inclusion support offers a cost-effective alternative to traditional deep foundations such as driven piles (concrete, steel or timber), augercast piles, and drilled shafts. The use of CMC rigid inclusions eliminates the requirement of a structural slab and grade beam foundation system and allows for a more economical spread footing and slab-on-grade approach. Additionally, the utilization of CMC rigid inclusions in lieu of deep foundations for support of multi-story structures has advantages seen in schedule, constructability, and cost.

BACKGROUND Typically, when soft soils are encountered, a deep foundation system consisting of pile foundations, pile caps, grade beams and a structural slab is recommended in order to bypass the soft material and transfer the load to more competent material. In comparison to a ground improvement approach, a deep foundation system requires elements to be tipped into either very dense/stiff soils or bedrock to transfer the entire structural load to a competent bearing layer. CMC rigid inclusions are designed so that a portion of the load

is carried by the existing soils with the remainder being supported through a combination of end bearing and skin friction – primarily skin friction in most cases.

CMC rigid inclusion support can be applied in several foundation design scenarios under multi-story structures such as footing-only support or a combination of footing and slab support. The load applied from the structure is transferred to the CMC rigid inclusions and underlying soil through

a Load Transfer Platform (LTP). The LTP typically consists of a well-graded, granular material which is placed in controlled, compacted lifts and can vary in thickness from 6 inches to greater than 2 feet. The purpose of the LTP is to “arch” the load between CMC rigid inclusions. The concept of arching, where stress is distributed from the structure to the CMC rigid inclusions and to a lesser extent the underlying soils is demonstrated in Figure 1. This figure also depicts the distribution of stresses within the zone of soil that is reinforced with CMC rigid inclusions.

CMC Rigid Inclusion Support for Multi-Story Structures

Advantages versus a deep foundation system

The primary advantage of CMC rigid inclusions for moderately loaded structures (ie, multi-story structures with as many as 13 stories) is the elimination of the need for deep foundations, structural slabs, pile caps and grade beams. One of the major benefits of using a ground improvement approach is the ability to construct a simple spread footing foundation and slab-on-grade system to support the same structural loading condition. Savings in schedule can be realized through the increased ease of construction of a spread footing/slab-on-grade approach as compared to all of the elements required of a deep foundation system.

Second, the constructability of a CMC rigid inclusion solution as compared

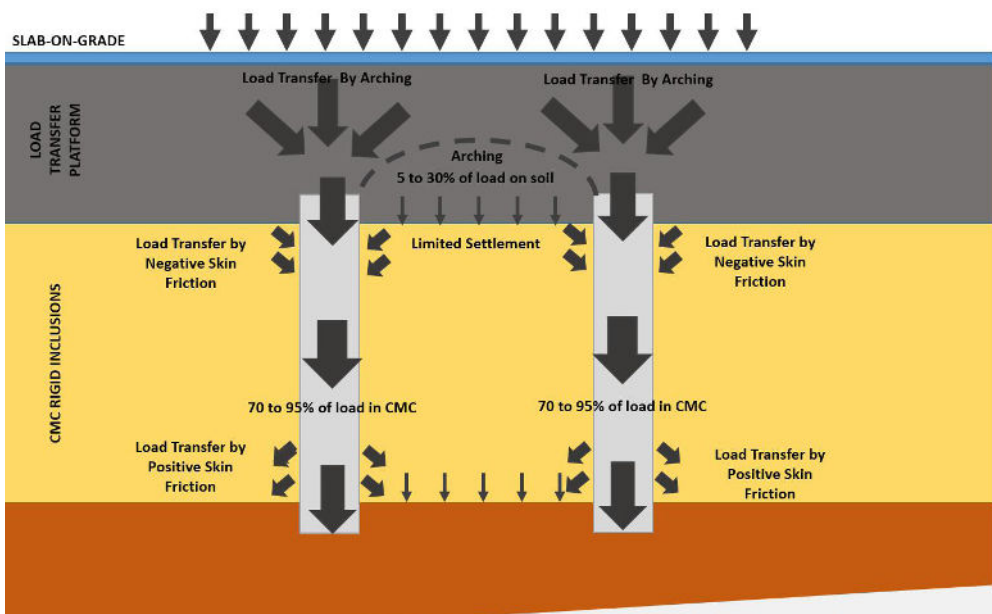


Fig 1: The CMC Rigid Inclusion and LTP system

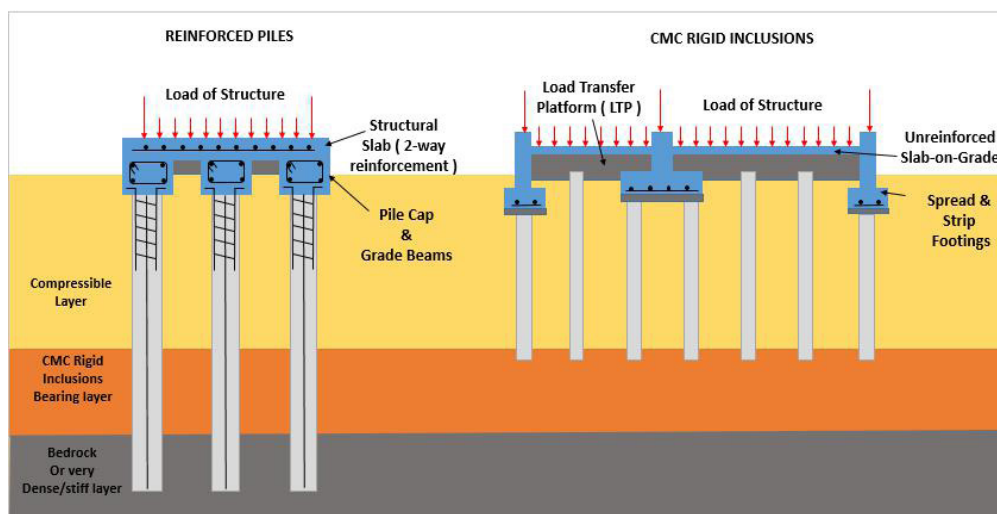


Fig 2: Comparison of Piled Foundation System to CMC with LTP

to a deep foundation system is simplified through the elimination of structural connections. Deep foundation systems require that deep foundations be attached to the structure via pile caps and grade beams. Structural connections are eliminated by using ground improvement solutions as there is no longer a need for direct connection between the CMC rigid inclusions and structure foundations. In many cases, with buildings supported on deep foundation systems, the utilities need to be supported by the floor slabs. With the CMC rigid inclusion system, utilities can be buried within the underlying LTP material or subgrade soils.

Third, significant cost savings are achieved by using CMC rigid inclusions as opposed to a deep foundation system. When comparing the costs of CMC rigid inclusions to deep foundations for support of multi-story buildings, it is important to consider all costs associated with the foundation systems – not just the costs of the CMC rigid inclusions vs the

deep foundations. Although it is common to see that more ground improvement elements than deep foundations elements are required to support the same amount of load, the overall foundation costs for the CMC rigid inclusion system is typically less than those of a deep foundation system

The overall savings are seen through the elimination of structural slabs and grade beams. A ground improvement approach allows for the reduction in slab thickness as well as the elimination of grade beams as load transfer is achieved through the LTP and CMC rigid inclusion system.

Case Histories Waltham Office Center (Waltham, MA)

Foundation and Slab Support

A 6-story office building was constructed in Waltham, MA in a previously developed wetland area. The site characteristics generally consisted of granular fill overlying very soft peat and organic material with dense sands and glacial till found at depths approximately 30 feet below existing surface elevations.

A CMC rigid inclusion approach was value engineered in lieu of driven piles in order to mitigate the settlement within the peat/organic layer and improve the overall bearing capacity of the site. A re-design of the proposed structure foundation allowed for the elimination of pile caps, grade beams and structural slab and implementation of spread footings (6 ksf bearing pressure) and a lightly reinforced slab-on-grade. The CMC rigid inclusions were successful at meeting the performance criteria of 1" total and ½" differential settlement. Menard was able to coordinate and work with the General Contractor to deal with issues ranging from obstructions, working platform stability, and design revisions to complete the project with minimal schedule impact.

Art Place at Fort Totten (Washington, D.C.)

Foundation Support

A six-story, mixed use (commercial and residential) structure was to be constructed in an area of previous residential development. The site required improvement of very soft sandy and silty alluvial soils in order to improve bearing capacity and settlement control. CMC rigid inclusions were used as an alternative to drilled shafts and allowed a footing bearing pressure of 8 ksf to economize foundation sizes and reduce overall foundation costs. Menard had to combat dewatering issues as well as working platform stability concerns in order to complete the project in a safe and timely manner.



Fig 3: Waltham Office Center



Fig 4: Art Place at Fort Totten

CONCLUSION Through the use of CMC rigid inclusions, Menard has provided multiple clients the ability to construct multi-story structures using spread footing foundations and lightly reinforced slabs-on-grade as an alternative to deep foundation systems. Through collaboration with the project team early in the development phase, significant savings can be obtained with the use of this ground improvement system.

GOING FORWARD: Do you have a project that you think would be a good candidate for a CMC rigid inclusion alternative to a deep foundation system?

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 to sign up for our newsletter, The Column.



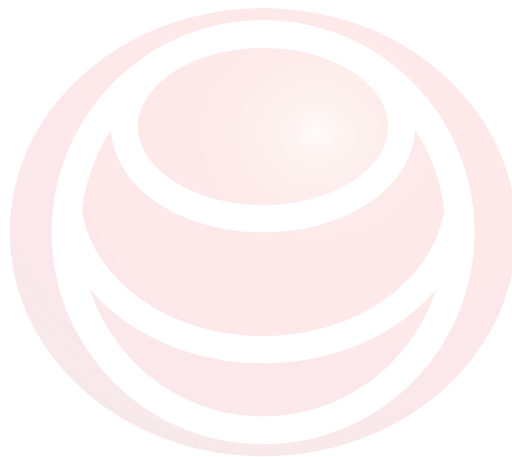
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