



## Mixed modulus columns - CMM®

Sustainable foundation solution

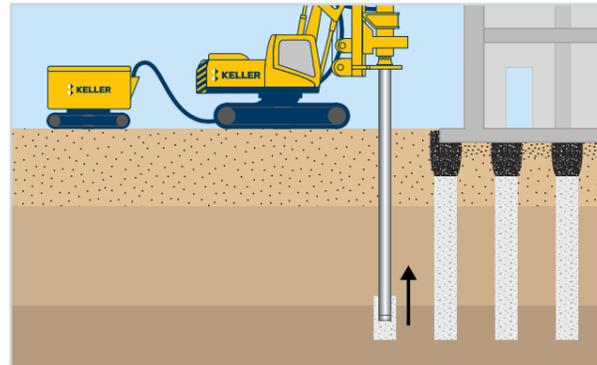
Geotechnical solutions for the construction industry

## Benefits

Soil reinforcement with mixed modulus columns (CMM®) is a sustainable ground improvement solution that combines two of our popular full displacement products. The solution involves the installation of high deformation modulus columns comprising a rigid inclusion and vibro replacement stone column. This forms a simple sub-structure design whilst avoiding the environmental impact of deep foundations. The combined system allows our clients to take advantage of the benefits that both of these products whilst negating some of the disadvantages that can exist when they are used in isolation.

## Common uses

- Industrial and commercial buildings
- Embankments for roads and rail
- Storage tanks and terminals
- Residential buildings
- Warehouses
- Public buildings
- Industrial flooring
- Wind turbines



## Applications

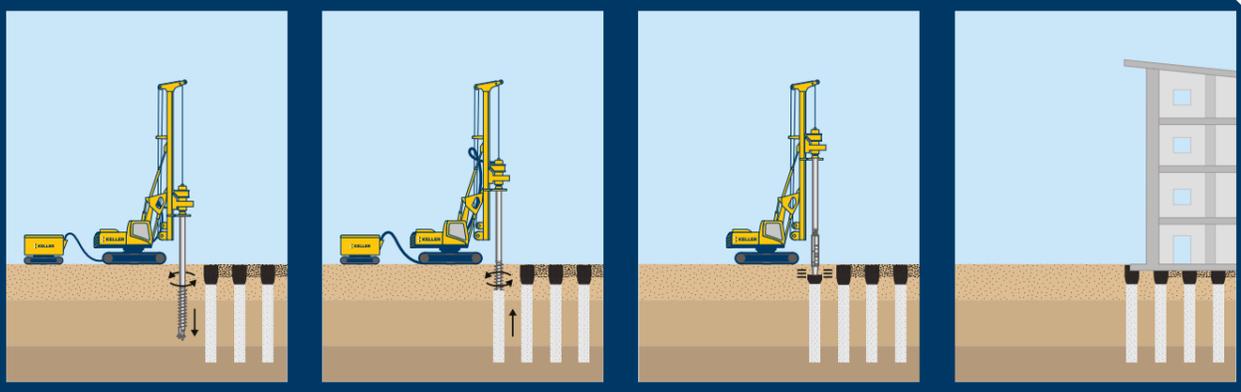
CMM® can be used in all construction sectors to treat a wide range of soils including backfills and low strength organic materials. Based on the initial compressibility of the soil the column spacing is adapted to achieve the specified settlement.

Typically CMM® improvement can increase the bearing capacity of soils to circa 150-200kPa, and up to 300kPa in optimum conditions.

No pile cutting is needed and the footings or slabs can rest directly on the improved soils.

## Process

A displacement auger or vibrated tube is used to penetrate down to the design depth from the working platform. Concrete is pumped as the tool is pulled upwards. Once the rigid inclusion is installed to a certain level, it is overlapped by and topped off with a column of gravel or crushed stone. After installation, you can form the foundations at a shallow depth (min 600mm below piling mat level) and construct ground bearing slabs on the rolled and compacted surface of the treated ground.

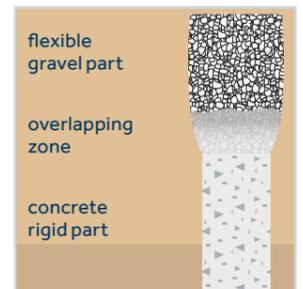


# Technical highlights

- Proven to reduce settlement and increase the bearing capacity of weak soils, even for high loads
- Reduces the load transfer thickness for flexible foundations
- Eliminates the risk of damage to the rigid inclusions
- Can be applied for most types of structures and most types of soils
- Reduces the bending point on a substructure
- Facilitates very rapid construction
- Facilitates conventional footing and ground bearing floor slab design
- Less spoil, less cement and no steel

## Design

CMM® design uses finite element methods (FEM) developed using Keller KID software. The object of a CMM® is to reduce settlement. Unlike conventional piles, the unreinforced rigid inclusion element only needs to be nominally embedded into the competent soil at depth. The rigid inclusion is topped off with a stone column, which overlaps by circa 500mm to ensure a suitable connection is made. The length of the stone column is adapted to the characteristics of the project such as the bottom level of the shallow foundations, rafts, and slabs or the soil being treated. This significantly reduces any bending moments on the substructure.



## Quality assurance

CMM® is controlled before, during and after installation to ensure the highest quality solution. A variety of tests can be carried out including:

- Field trials for verifying column production parameters
- Digital recording and logging of the execution parameters through full rig instrumentation
- Column load testing and material compressive strength tests

The type and frequency of tests vary based on the size and geotechnical complexity of a project.

## Our commitment to sustainability

At Keller, we are committed to better understand our contribution to sustainable development and work collaboratively with our customers and stakeholders to reduce potential impacts.

We offer:

- Soil remediation and prevention of contamination: Cost effective and environmentally-beneficial soil remediation solutions to reduce contaminants to levels which are suitable for use without environmental risks or danger to health.
- New materials and design solutions to reduce carbon: Lower carbon products to help clients reduce the carbon footprint of their projects, as well as carbon measurement and offsetting.
- Reducing spoil and materials: Innovative solutions to help clients reduce and/or reuse spoil generated from some ground improvement techniques, like piling and grouting, saving the cost of removal from site and disposal.

Mixed Modulus Columns CMM® for example have less spoil, less cement and no steel making them one of the most sustainable techniques for ground improvement and structural support.

## Clairwood Logistics Park, KwaZulu-Natal, South Africa

Mixed modulus columns (CMM®), comprising rigid inclusions and a gravel head, were used as the ground improvement solution to support the 350,000m<sup>2</sup> Clairwood Logistics Park Development located in KwaZulu-Natal.

Ground improvement using CMM® proved to be the optimal solution to overcome the challenging geotechnical conditions. Driving a tube with a ring vibrator was the best way to install over 45,000 CMM® to depths of up to 40m. The CMM® is completed with a gravel head constructed using a Keller Vibrocat.

The project is the largest ground improvement project undertaken by Franki Africa, and one of the largest of its kind in the world.

### Keller Africa

Geotechnical specialist contractor  
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