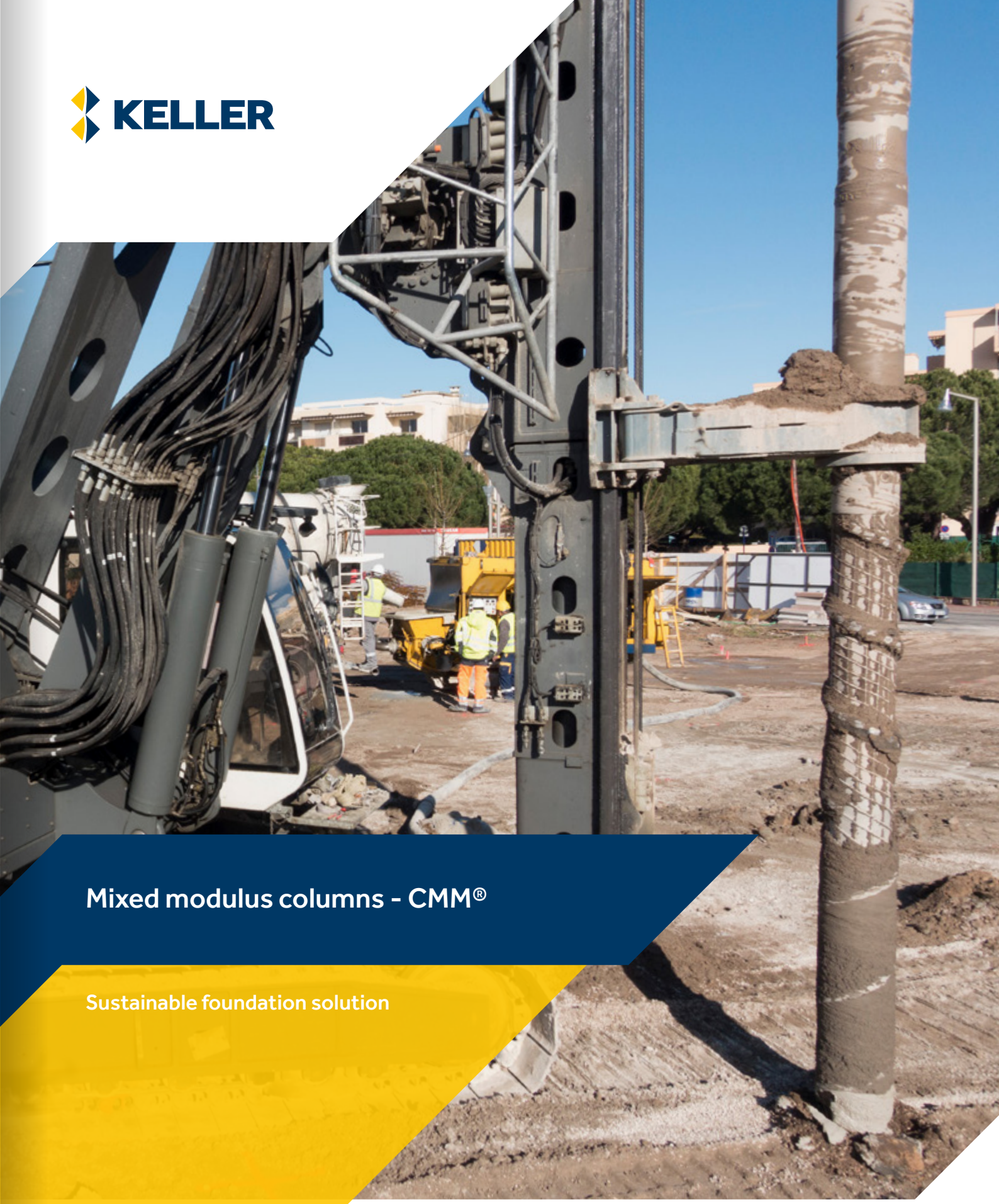
KELLER



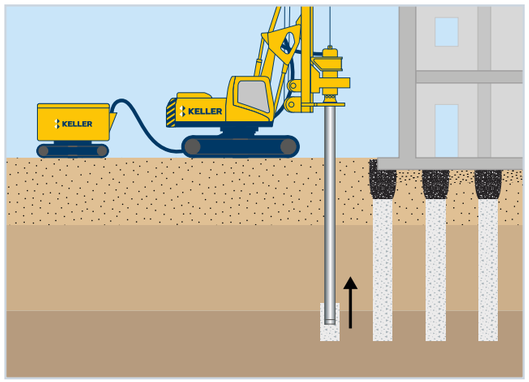
Mixed modulus columns - CMM®

Sustainable foundation solution

Geotechnical solutions for the construction industry

Benefits

Soil reinforcement with Mixed Modulus Columns (CMM®) is a sustainable ground improvement solution which combines two of our popular fully displacement products. The solution involves the installation of high deformation modulus columns comprising a hybrid of a Rigid Inclusion and Vibro Replacement Stone Column, so as to facilitate simple sub-structure design whilst avoiding the environmental impact and legacy of deep foundations. The combined system allows our clients to take advantage of the benefits that both of these products have to offer 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 and can be adopted 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 so as to suit the allowable settlement of the project.

Typically CMM® improvement can increase the bearing capacity of the 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

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

Technical highlights

- Proven method to reduce settlement and to 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
- Minimal spoil
- Can be applied for most types of structures and most types of soils
- Reduces the bending moment on substructure
- Facilitates very rapid construction
- Facilitates conventional footing and ground bearing floor slab design

Design

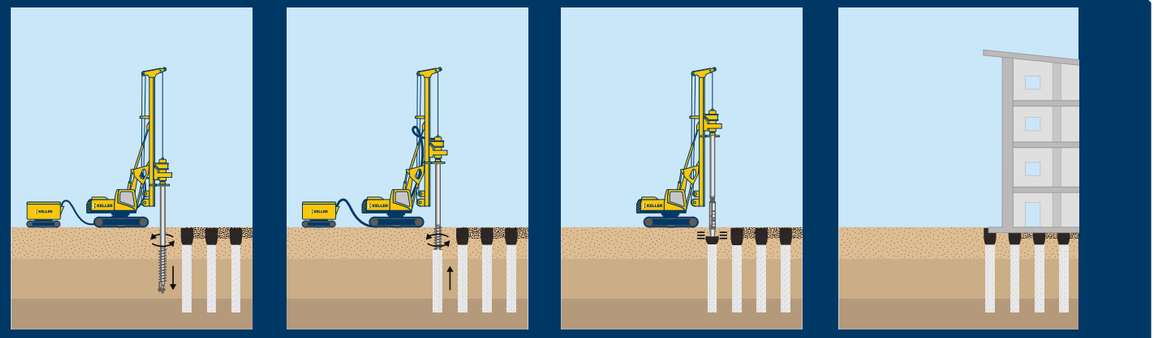
CMM® design uses finite element methods (FEM) developed using Keller KID software. The object of a CMM® is to reduce settlement. Unlike conventional piles, the unreinforced rigid inclusion element only needs to be nominally embedded into the competent soil at depth. The rigid inclusion is topped off 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® are 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 & material compressive strength tests

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



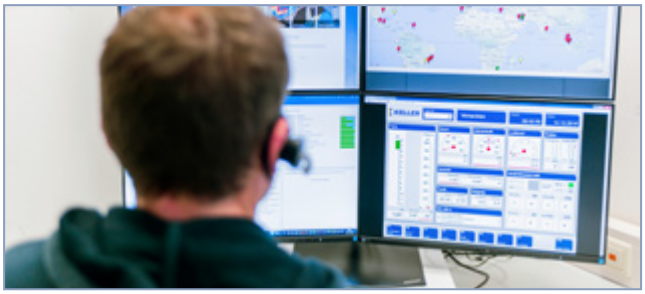
Keller sustainability

Reduced spoil, fuel and traffic

- Displacement installation
- Shallower footings
- Less muck away, cost and landfill

Reduced groundworks

- No cutting / trimming
- Can track over columns
- Rapid installation
- No full time attendance



Fully instrumented installation and modern equipment

- GPS real time data
- Concrete take
- Depths/extraction
- Energy/resistance
- Time
- Tier 4 final engines
- Idle cut-off

Reduced steel and concrete

- No steel in the columns
- Less steel in the foundations and floor slabs
- Columns topped with stone
- Shallow foundations / thinner slabs
- Reduced embodied carbon emissions of circa 80-100kg* CO_2e per column

*denotes reduction over full length rigid inclusions. Bigger reductions are calculated over concrete piles.

Keller UK

Geotechnical specialist contractor
www.keller.co.uk

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