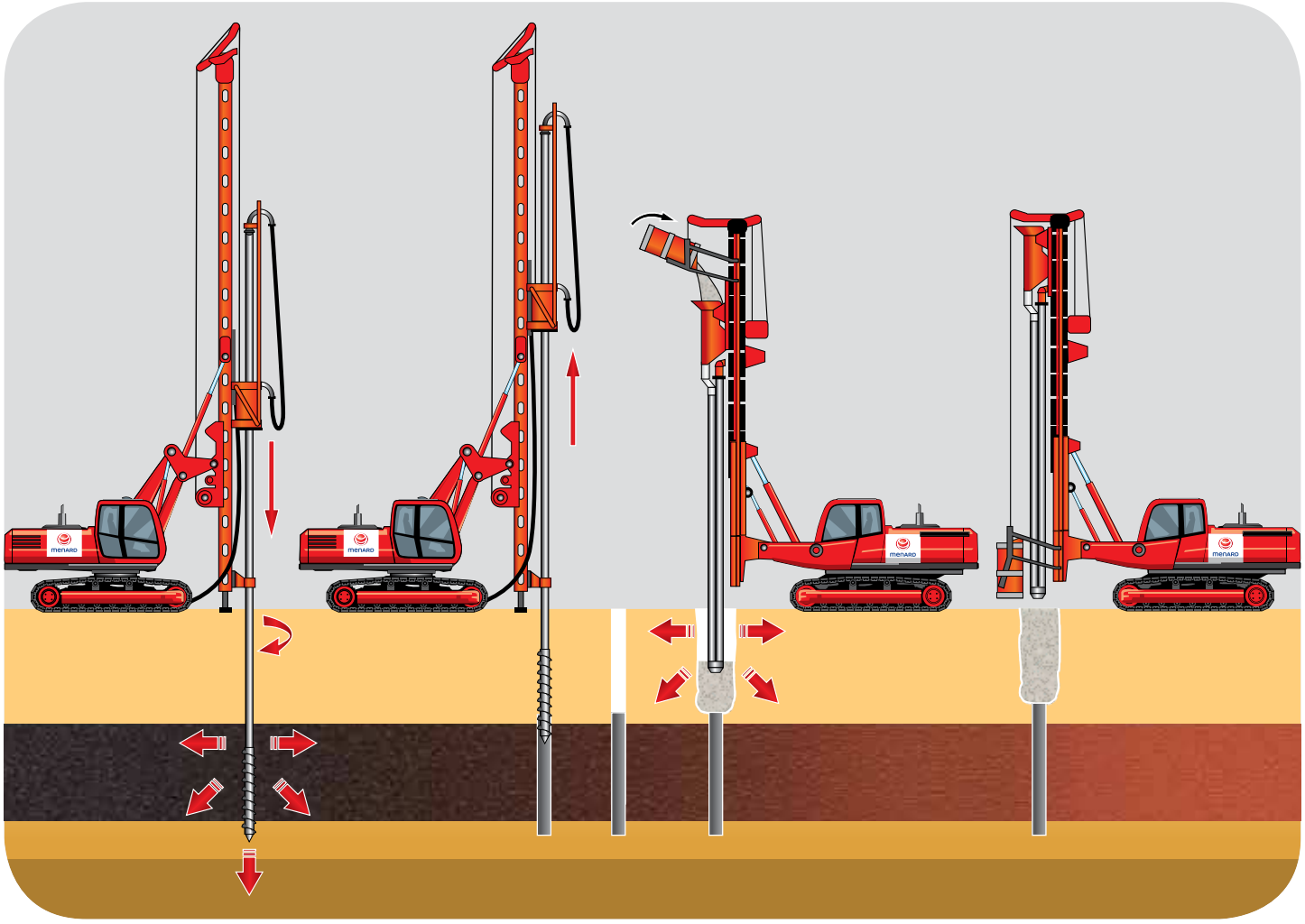
Bi-Modulus Columns (BMC)

menard

ground improvement specialists

The Bi-Modulus Column (BMC) technology is complimentary to the technology of concrete columns – Controlled Modulus Columns (CMC) and to the technology of gravel columns - Stone Columns (SC), combining advantages of both. The technology was firstly implemented in the 1990s in France and in the USA, and since that time, it is wide spreading all over the world.



Technology specification

The BMC (Bi-Modulus Columns) soil improvement technology consists of several stages.
The BMC core is made in the same way as the CMC (Controlled Modulus Column) core. A specially designed displacement auger installed on a machine equipped with a high torque and static vertical thrust head displaces the soil horizontally towards the hole centerline. When the displacement auger reaches the required depth the injection grout based on a concrete mixture is pumped under pressure to the hole. The pumped concrete flows through the auger pipe. The concreting process is performed under a pressure which does not cause any damage to the hole walls and prevents from mixing the soil with the injection grout.

A BMC head is formed applying the SC technology in a point of construction of the CMC core.
By a specially designed downhole vibroprobe installed on the equipment assembly the BMC head is formed in three basic stages:

- vibroprobe driving - the vibroprobe is driven into the soil to the design depth, most often ranging from 1.0 to 3.0 m; the driving process is often supported by the supply of compressed air or water
- aggregate backfill - the space formed during the first stage is filled with aggregate
- compaction – the backfilled aggregate is compacted in steps, most often every 0.5 m; this is the way to form a column with a diameter ranging from 40 to 120 cm.

Application

The BMC technology is a kind of supplement to the CMC technology, therefore it can be used analogically to the CMC applications in almost any soil conditions. The technology works well in soft loams and silts, anthropogenic soils (uncompacted fills, heaps) and in organic soils (peat, aggradate mud, gyttjas) with a moisture content above 100% if deposited below the bottom level of the granular fill.
The application of the BMC usually results from the necessity to create a transition layer between the constructed structure and the subsoil reinforced with the columns as well as the force distribution between the two. The BMC technology can be applied to all kinds of structures such as enclosed buildings (foundation slabs), infrastructure (road and rail embankments) and special structures (wind turbine foundations).
Typical loads transferred by the column are within the range from 250 up to 600 kN. The columns are located similarly to the CMCs and SCs, i.e. in a square or triangular grid with a side length ranging from 1.5 m up to 3.0 m. Most commonly the granular fill has the diameter ranging from 2 up to 4 times larger than the concrete column core.

Projects

Enclosed buildings:

Residential buildings, office buildings:

- Apartment and commercial building complex at Saska Kępa II street, Warsaw, approx. 10,800 lin. m.

Infrastructure:

Road and rail embankments:

- Ełk ring road, approx. 16,200 lin. m.
- S7 National Road, Kalsk - Miłomłyn, approx. 10,500 lin. m.

Special structures:

Wastewater treatment plants, silos, tanks, wind farms:

- Żuromin II Wind Farm, approx. 1,000 lin. m.

Advantages:

- **Powerful combination** – the BMCs combine advantages of the Stone Columns and the Controlled Modulus Columns. The soil is not over-stiffen and there is no risk of column buckling or bulging.

- **Economy** – the reduction in the thickness of the platform transmitting the load from the structure to the improved soil, optimization of the geosynthetic layer thickness and fast construction of the BMCs - these are only selected aspects that make this technology economical.

- **Comprehensive improvement** – the improvement of mechanical properties of the soil between the columns, and while forming the column by swelling / compacting the soil.

- **Versatile application** – the application to almost any soil type including compressible, organic (peat, aggradate mud, gyttjas) and man-made soils.

- **Environmentally friendly** – in the course of the BMC core formation the surface soil structure is undamaged and there is no excavated material. Hence, no need for removal of earth mass. The granular fill of the column may be formed from recycled material (concrete rubble).

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