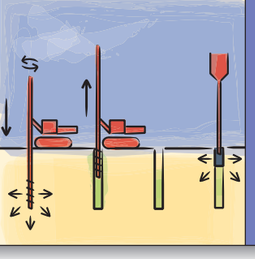


Bi-Modulus Columns

Advantages

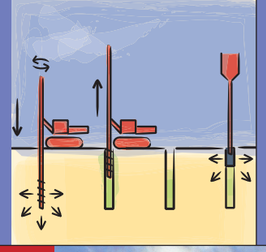
- Because the load transfer is optimized to reach the maximum use of the upper soil layers, the design of a Bi-Modulus Columns system usually results in a reduction in the thickness of the load transfer platform and therefore minimizes the need for import of granular quality backfill;
- Bi-Modulus Columns can be used to overcome complex cut-off problems (deep cut-off with highly variable elevations...) when the surrounding soils are too soft for a more classical stone column support to be designed;
- The use of Bi-Modulus Columns can be a efficient alternative to the requirement of a load transfer mat under shallow footing and rigid inclusions in case of severe seismic effect.

Applications

Common applications include :

- Industrial warehouses and commercial buildings;
- Condominium, apartment buildings, townhouses and single-family residential developments;
- Reclaimed platforms (harbours, container terminals);
- Sewage treatment plants;
- Railway and Roadway embankments;
- Retaining walls;
- Liquefaction mitigation and building support in seismic areas.

2, rue Gutenberg - BP 28 - 91620 NOZAY
Tel. : 33(1) 69 01 37 38 Fax : 33(1) 69 01 75 05
www.menard-web.com

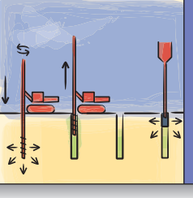


Bi-Modulus Columns

Bi-Modulus Columns are vertical soil reinforcement elements composed of Rigid Inclusions topped by a compacted granular material. Granular upper part improve the load transfer and stress distribution from the structure to the rigid inclusions, which leads to the optimization of the thickness of the load transfer platform between the structure and the inclusions.

Bi-Modulus Columns combine the advantages of regular Stone Columns (ease of excavation of the footings...) without the limitations in very soft soils where a Stone Columns solution would not be recommended due to the lack of lateral confinement and the risk of bulging.

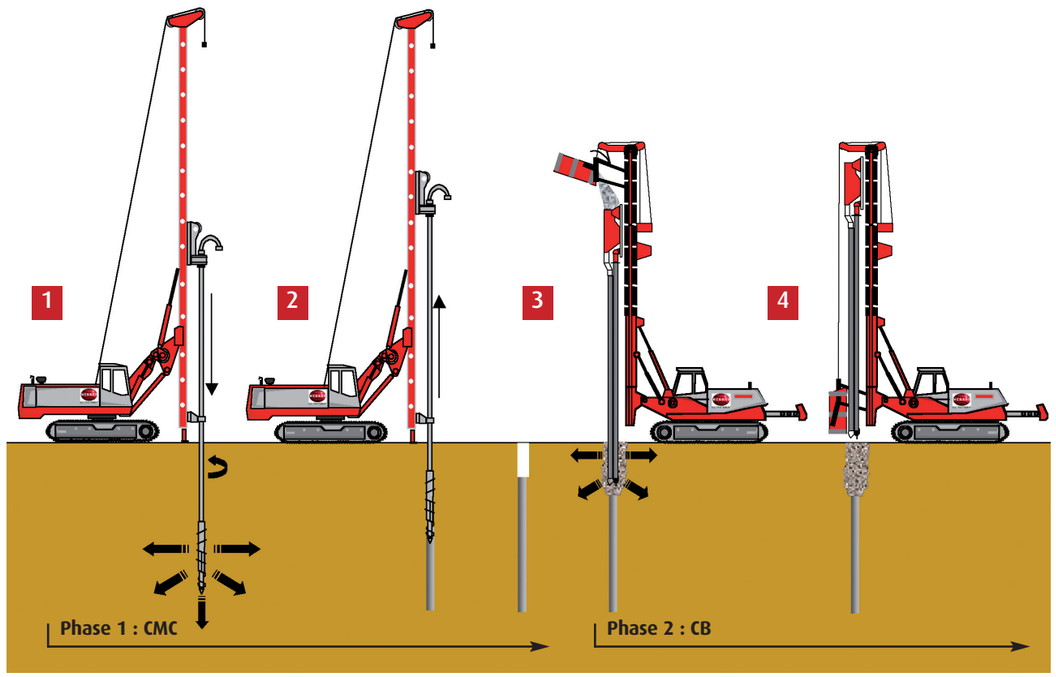
The upper granular part of the column is installed before complete setting of the rigid inclusion's mortar in order to form a transition zone, made of a mix between the grout of the inclusion and the stones from the granular tops. In this transition zone, an optimal concentration and transfer of the surface loads to the underlying competent soil layer can be developped.



Bi-Modulus Columns

Implementation and methods

Bi-Modulus Columns are performed in two consecutive phases according to the following process:



1) The bottom part of the Bi-Modulus Columns (BMC) is installed using implementation similar to the Controlled Modulus Column (CMC) process with a typical diameter of 250 to 450 mm, using a full displacement auger.

2) When the required depth is reached, the grout is pumped through the hollow stem of the auger in order to form a grouted inclusion with improved bonds to the surrounding soil, due to the displacement drilling process. No extraction nor soil mixing takes place during the grouting of the column under moderate pressure. No spoil is generated on the working platform.

3) The upper part of Bi-Modulus Columns is using implementation and methods similar ther Stone Columns process, by inserting an vibroflot associated with a pressure chamber equipment and air jetting. The probe is vibrated to the required depth, generally between 1 to 3 m.

4) As the probe is lifted, the ballast material falls down by gravity in the void that is created. The process is enhanced by continuous injection of compressed air. The aggregates are inserted and compacted by extraction and re-penetration of the vibrating probe through repeated incremental lifts of 30 to 50 cm each cycle being repeated till the probe reaches the surface.

Excavation of a Bi-Modulus Column :

The upper granular part of the BMC are performed between 4 to 10 hours after completion of the lower rigid inclusion. This planned phasing warrants that the effectiveness of the compaction of the granular tops as well as optimum mixing conditions between the ballast and the grout in transition zone. The quality of the performance of the interface between the rigid inclusion and the stone column is a key component in the effective distribution and transfer of the loads between the structure and the lower competent soil layers.

Stone Column

Interface

Controlled Modulus Column