



SOLTRAITEMENT

Soil Improvement Specialists



Design, Construct... Perform

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Airbus Factory (EADS) in Hamburg - Germany



Overview

From design to construction, MENARD SOLTRAITEMENT offers a complete service for improving soils. MENARD SOLTRAITEMENT techniques are cost-effective alternatives to deep foundations.

A Full Service

With the geotechnical know-how gained through the completion of thousands of contracts, MENARD SOLTRAITEMENT consistently delivers the essentials for success: a firm price, a reliable schedule, predictable construction and a commitment to excellence in both construction and service.

A Turnkey Solution

Based on the preliminary soil investigations and on the type of structure to be built, MENARD SOLTRAITEMENT selects the most appropriate soil improvement technique. The selection process is based on soil, structure and environmental constraint analyses. MENARD SOLTRAITEMENT engineers then carry out detailed design studies; the subsequent construction is performed by dedicated teams available in more than 50 locations worldwide.

State-of-the-Art Technology

MENARD SOLTRAITEMENT has improved and developed many new soil improvement methods over the past 30 years. A fundamental objective for the company is to lead the soil improvement industry by applying accrued efficiency, dependability and cost-effectiveness to each project. This objective applies to methods relating to in situ measurement and monitoring, finite element methods, as well as optimizing the use of conventional construction equipment in the field.



Nice Airport - France

History

The history of MENARD SOLTRAITEMENT has been punctuated with a series of world firsts, each demonstrating the company's inherent capacity to innovate. Today, MENARD SOLTRAITEMENT is a major player on the construction stage.

- | | |
|------|--|
| 1955 | Invention of the MENARD Pressuremeter. |
| 1969 | Invention of DYNAMIC COMPACTION (DC™) for sandy soils. |
| 1975 | Development of DYNAMIC REPLACEMENT (DR™) for clayey soils. |
| 1977 | First major contract outside France: Changi Airport, Singapore. |
| 1988 | First MENARD Vacuum™ application in France. |
| 1994 | Development of Controlled Modulus Columns (CMC™). |
| | |
| 1977 | Singapore Airport - First vertical drain to 43 m depth. |
| 1978 | Nice Airport - France - Deepest Dynamic Compaction Jobsite, 27 m (4 000 tm). |
| 1989 | European Space Center - French Guyana - 300 tons highest load test on DR pillar. |
| 1998 | Jangyoo sewage treatment plant - South Korea - Largest induced settlement on a soil improvement jobsite (5.5 m). |
| 2001 | Airbus Industries in Hamburg - Germany - Largest single contract value for soil improvement. |



Submarine Compaction - Kuwait

Techniques

MENARD soil improvement techniques meet the most demanding requirements. They comprise two basic options.

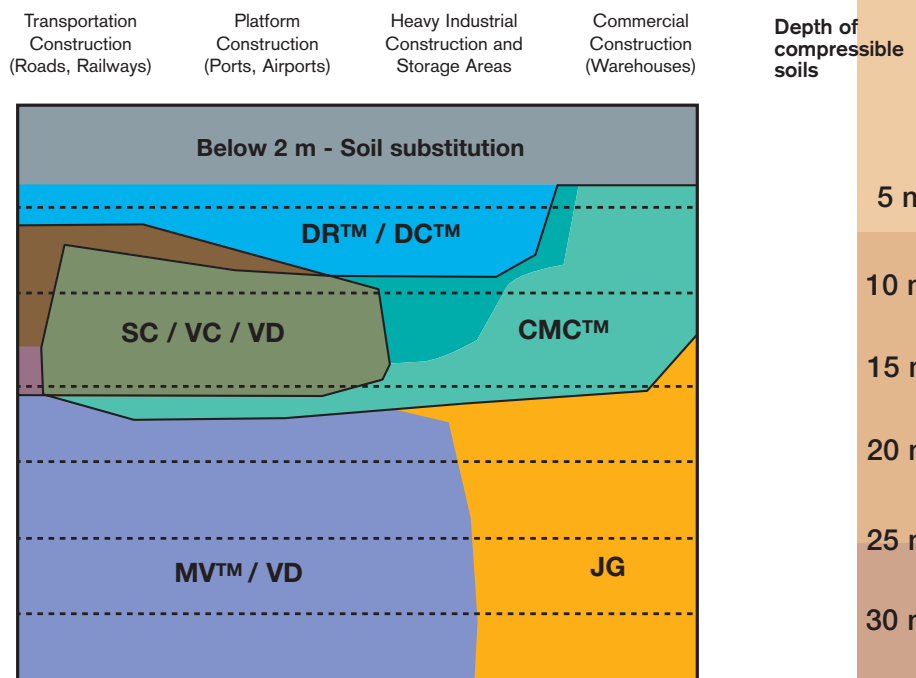


700 tm Dynamic
Compaction Equipment
MENARD Design

Improvement without additional material

For granular soils (sand, gravel), densification is achieved by compaction or vibratory methods. For cohesive soils (clay, silt), consolidation by pre-loading by constructing an embankment or applying vacuum (Menard process) can be significantly accelerated through the use of a drainage system.

The diagrams below and on the next page illustrate the selection of a soil treatment technology as a function of structure, soil type and the depth of the compressible soil.



Legend

- SC STONE COLUMNS
- VC VIBRO COMPACTION
- DC™ DYNAMIC COMPACTION
- HDC™ HIGH DYNAMIC COMPACTION
- DR™ DYNAMIC REPLACEMENT
- CMC™ CONTROLLED MODULUS COLUMNS
- MV™ MENARD VACUUM
- JG JET GROUTING
- VD VERTICAL DRAINS

Techniques

Improvement with additional material

These techniques consist in making flexible, rigid or semi-rigid vertical inclusions in the compressible soil layers. These inclusions are laid out following a regular surface grid. The good quality material used are either dry and cohesionless (stone columns and dynamic replacement pillars) or grout based products (controlled modulus columns and jet grouting). The resulting consolidated soil layer behaves like a composite material with improved characteristics.



CMC Rig
MENARD Design

Depth of compressible soils

5 m

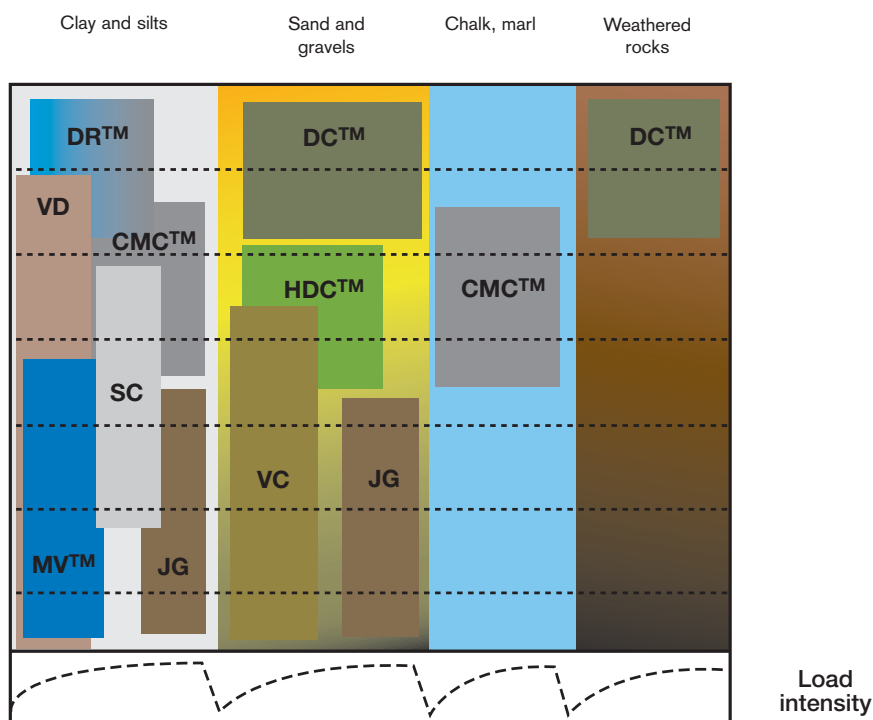
10 m

15 m

20 m

25 m

30 m



Menard Soltraitements around the world



Dynamic Compaction



Stone Columns
(Bottom Feed)



Vertical Drains



Controlled Modulus
Columns



World

www.menard-soltraitement.com



MENARD SOLTRAITEMENT's services are available all around the world, through its subsidiaries and agents. This worldwide network with bases in almost 30 countries allows MENARD SOLTRAITEMENT engineers to meet the most ambitious needs of their clients all around the world.

The Scientific Division and Technical Department of MENARD SOLTRAITEMENT make innovations and know-how available to everyone within the group. Thus, each client benefits from solutions that have been tried and tested in several completed projects.

Transportation Construction - Roads, Railways

Objectives

- reduce long-term differential settlement;
- guarantee circular stability of high embankments.

For transportation engineers, it is often difficult to avoid building on highly compressible soils. For example, in the case of crossing wetlands and rivers, it is necessary to consolidate the in-situ soil in order to avoid slope failure of the future road embankments during construction. Preconsolidation of the most compressible areas is necessary to prevent long term creep settlement. The consolidated soil foundation will increase the service life of the road pavement, thus reducing life-cycle costs for the roadways and structures. Approach embankments which lead to bridge structures can produce critical loads in subsurface soils up to 20 t/m². The designs for these foundations often require intensive treatment to improve the soils.

References:

ASF, Camrail, Deutsche Bahn, Eurotunnel, Federal Highway Authorities, Korea Rail Road Authority, P.L.U.S. Malaysia, SNAM, US Department of Transportation, Scetauroute, SNCF.

Menard Vacuum consolidation™ under the Boutonne river of approach embankments for A537 expressway (France).



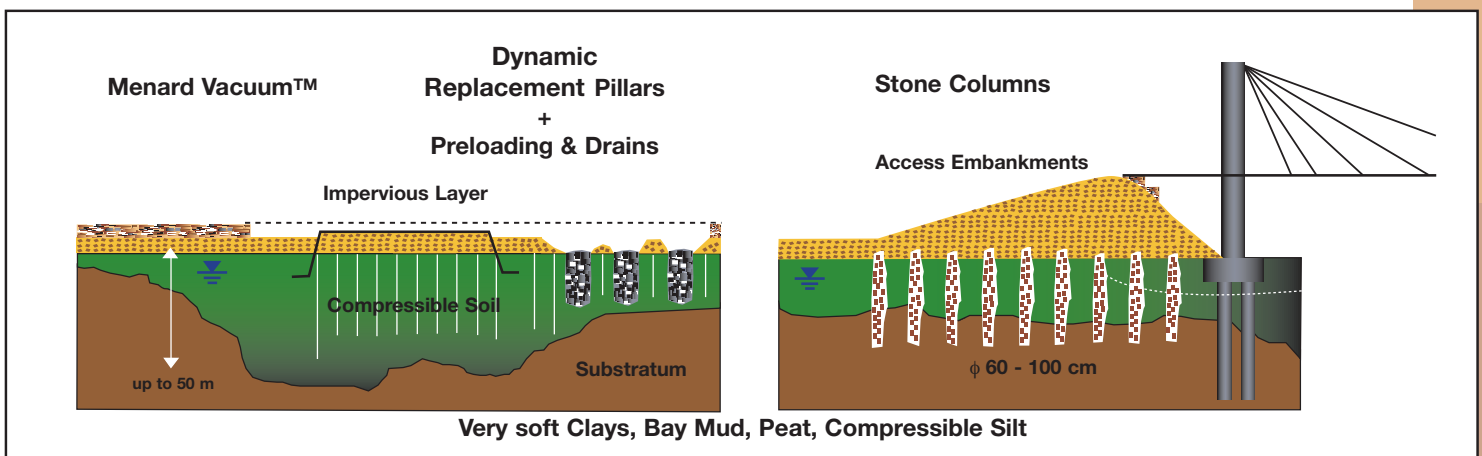
Strengthening by Vacuum™ of the Eurotunnel rail station at Coquelles (France). View of the station after construction.



Installation of vertical drains at 25 m depth in clay under the Rabat-Larache expressway (Morocco) to consolidate the road embankments by preloading.



Soil Improvement by CMC™, below access embankments to bridge. View of site after erection of fill.



Heavy Industrial Construction Storage Areas

Objectives

- provide bearing capacity of up to 20 t/m²;
- allowable isolated loads of up to 300 t;
- reduce differential settlements to around 1/1000.



Consolidation using preload & dynamic replacement in Tsing I & II Hong Kong oil storage. (China Petroleum Company)



Menard Vacuum Treatment™ to preload 40 m of very soft marine mud at Pusan (South Korea) sewage treatment plant. View of the membrane during the Vacuum application.



Turnkey foundation system including preloading, Dynamic replacement under infrastructures. Jet grouting under heavy tanks.



Pusan sewage treatment plant after heavy tanks soil improvement and construction (Korea).

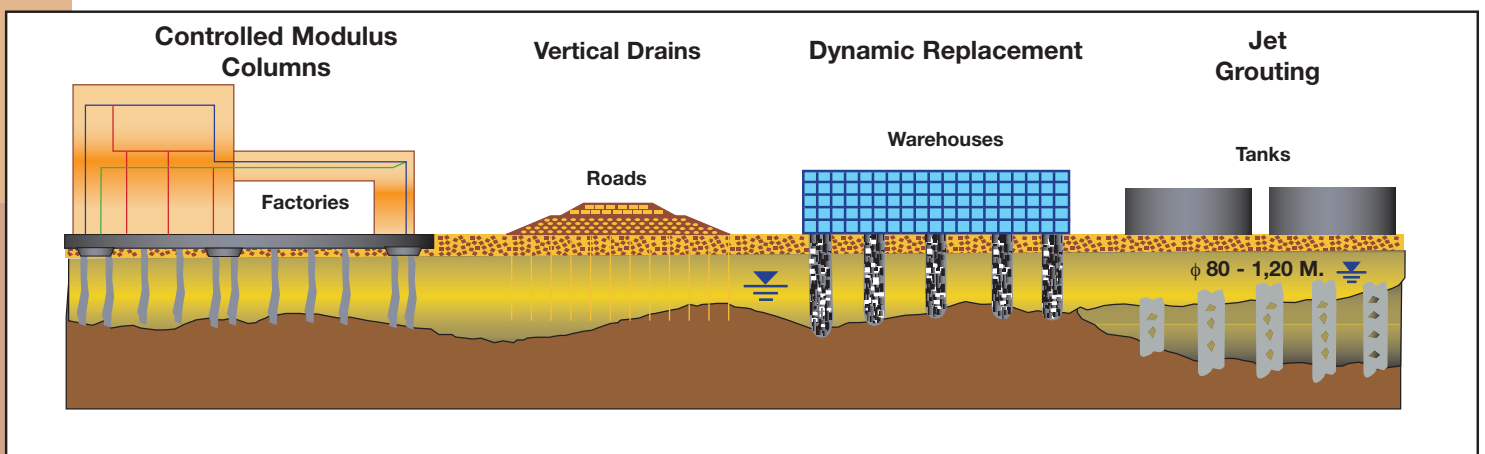
Identifying the most effective foundation system, which guarantees smooth and safe performance over time, is the objective for MENARD engineers. This is especially true when dealing with compressible soils. The most cost-effective foundation system often requires using multiple soil improvement techniques that take into account the variety of soil properties and load conditions.

The most frequent challenges are:

- support of uniform heavy loads (water, oil, gas storage) and concentrated loads (industrial, infrastructures, pipe-racks),
- reduction of total and differential settlements to within acceptable limits.

References:

ABB, Agip, Amoco, Bayer AG, Bechtel, Caltex-Exxon/Mobil, Chevron, China Petroleum Corp., Elf/Antar, Formosa Plastics, Foster Wheeler, JGC, Mitsubishi Heavy Industries, Mobil/NNP, Parsons, Péchiney, Phillips Petroleum, Saudi Royal Commission, Technip, Total, Petronas.



COHESIVE SOILS

Objectives:

- self-bearing of fill;
- long term residual settlement.

Construction projects at ports and airports involve vast amounts of land area. Often the land needed is reclaimed from wetlands or in water by using dredged or imported fill materials. This presents a challenge for the engineer to identify an economical means to improve such large quantities of soil.

Platform Construction -

Port of Wismar (Germany) -
Pre-consolidation of the TPC
(22,000 m²) using Menard
Vacuum Consolidation™.



Port of Lubeck (Germany) -
Consolidation of Baymud.



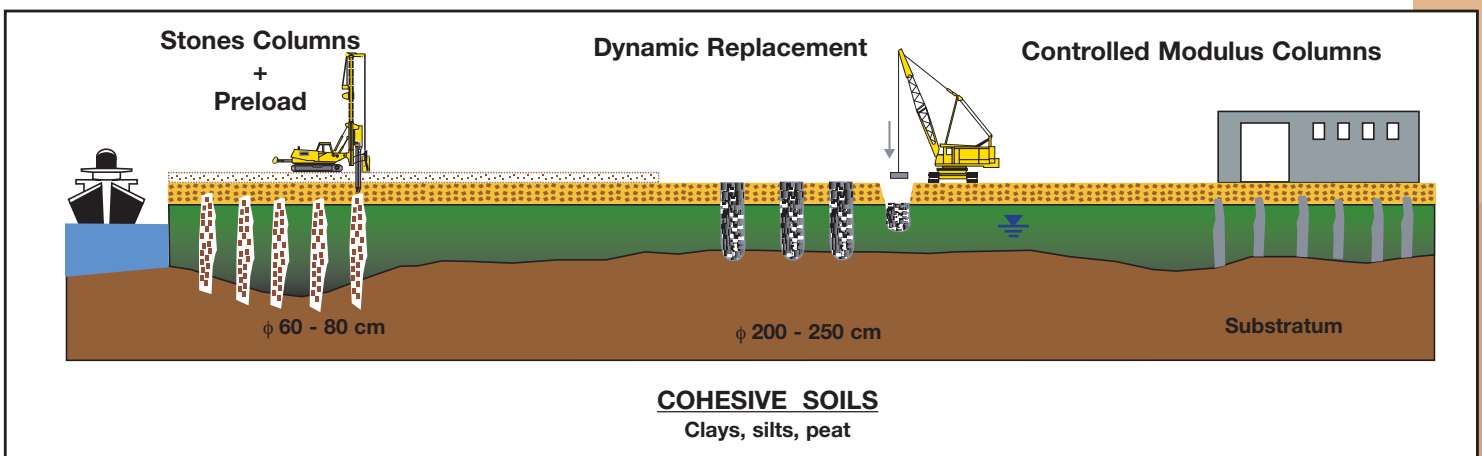
Typical cross-section of Port
of Lubeck after construction.



References:

Port of Dunkerque, Port of Guadeloupe, Port of Hamburg,
Port of Le Havre, Port of Kaohsiung, Port of Long Beach,
Port of Lubeck, Port of Nantes S' Nazaire, Port of
Singapore, Port of Paris, Port of Pusan, Port of Taichung,
Port of Uddevalla, Port of Wismar.

Installation of Dynamic
Replacement Pillars
under the Kourou Railway
(French Guyana) between
Ariane 5 construction area
and launching pad.



Objectives:

ports and airports



Treatment to a depth of 15 m using vibro compaction in Pasir Pajang (Singapore).

- self-bearing of fill;
- increase surface bearing capacity;
- liquefaction mitigation (seismic areas).

The engineer's primary objective is to use a soil treatment which stabilizes the fill for both short-term and long-term performance. Working with the owner, Menard engineers select the most effective treatment which will increase the bearing capacity under the proposed structures. Menard's engineered solutions consider a range of potential soil conditions and natural events, including liquefaction mitigation in seismic areas.



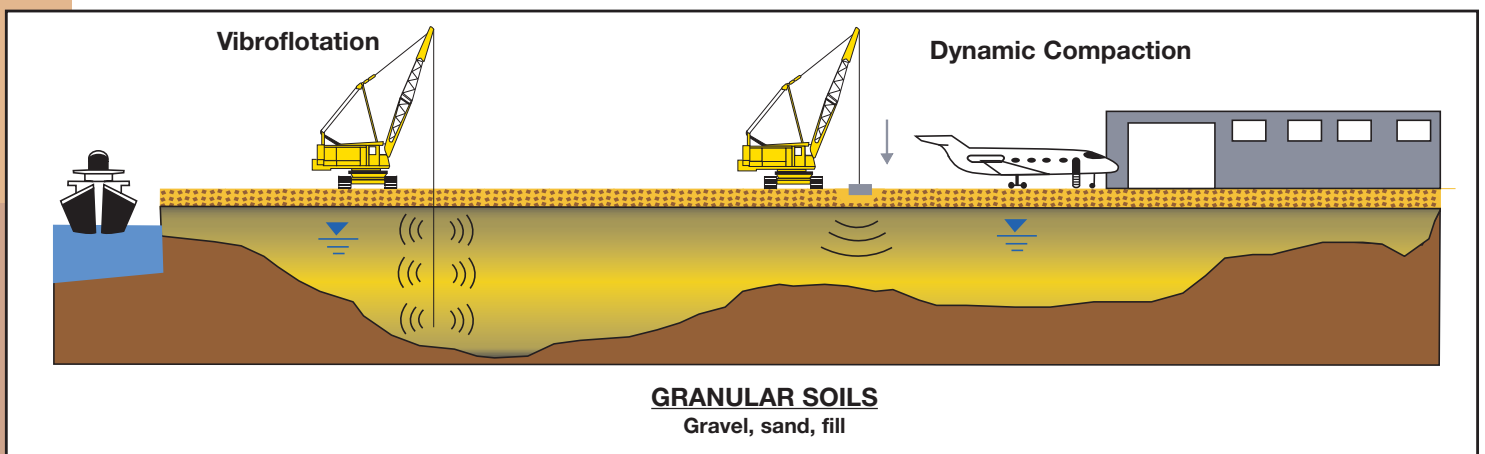
Dynamic Compaction of Macau International Airport's apron.



Consolidation by Dynamic consolidation in Osaka (Japan) airport's artificial island using a Tripode with 1400 TM energy (drop height times pounder weight).

References

Port of Beyrouth, Port of Long Beach, Port of Singapore, Hong Kong Airport, Macao Airport, Nice Airport, Osaka Airport, Singapore Airport.



Commercial construction - warehouses

Objectives:

- Allow concentrated loads up to 200 t;
- Allow uniform floor loads up to 7 t/m²;
- Reduce differential settlement to around 1/1000

Loads induced by commercial structures, such as slabs-on-grade and footings, are well adapted to soil improvement technologies.

Depending on the in-situ soil properties, Menard engineers rely on three particularly cost-saving foundation systems: Dynamic Replacement™, Stone Columns, Controlled Modulus Columns™

Steel structure warehouse with 80 ton footings and 3 t/m² slabs loading.



Outside view of a logistic warehouse founded on DR™ pillars.



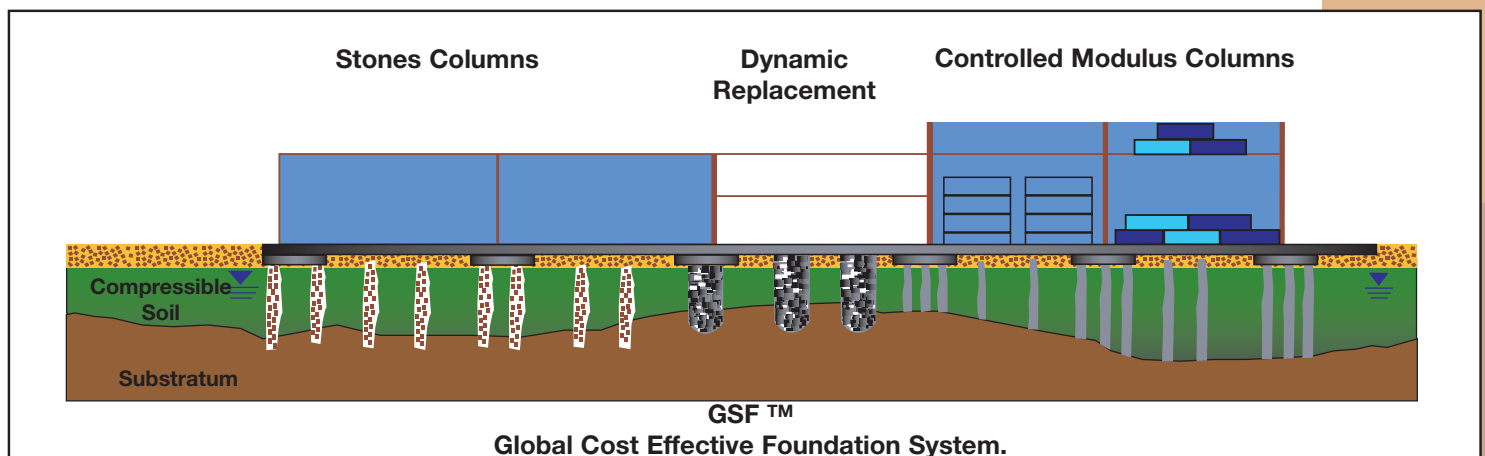
Multi-level storage on slabs. Uniform loading max of 5 t/m². Max allowable differential settlement: 0.8/1000.



References:

Auchan, BEG, Black & Veatch, Casino, Calberson, Carrefour, Castorama, CIA, CVZ, Danzas, Décathlon, Eurodisney, IEE, Intermarché, Leclerc, Metro, Novatrans, Samsung, Stockalliance.

Commercial building, pillars and slabs structure.





SOLTRAITEMENT

Offices Around the World

Australia

MENARD Representative
AUSTRESS FREYSSINET PTY LTD

37, Prime Drive
Seven Hills
SYDNEY N.S.W. 2147
Tel.: (61.2) 96 74 40 44
Fax: (61.2) 96 74 59 67
E-mail: austress@freyssinet.com.au

Belgium

MENARD Representative
FREYSSINET BELGIUM N.V.

Harenesteenweg 299
1800 VILVOORDE
Tel.: (32.2) 252 07 40
Fax: (32.2) 252 24 43
E-mail: info@freyssinet.be
Contact: Claude MORTIER

Canada

MENARD Representative
REINFORCED EARTH
COMPANY LTD

The Enterprise Centre
1550 Enterprise Road, Suite 229
Mississauga – ONTARIO L4W 4P4
Tel.: (1.905) 564 0896
Fax: (1.905) 564 2609
Contact: Peter WU

Egypt

MENARD Representative
FREYSSINET EGYPT

76 El-Mahrousa Street
12411 El-Mohandseen
GISA
Tel.: (20.2) 303 69 65
Fax: (20.2) 345 52 37
Contact: Seif El SAWAH

France

MENARD SOLTRAITEMENT

Zone de la Butte
2, rue Gutenberg – BP 28
91620 NOZAY
Tel.: (33) 1 69 01 37 38
Fax: (33) 1 69 01 75 05
E-mail:
mail@menard-soltraitement.com
www.menard-soltraitement.com
Contact: Philippe LIAUSU

Germany

MENARD DYNIV GMBH

Heim-Sass-Weg 21
22129 HAMBURG
Tel.: (49.40) 30 23 98-0
Fax: (49.40) 30 23 98-25
E-mail: jlchaumeny@menard-hh.de
Contact: Jean-Luc CHAUMENY

Greece

MENARD Representative
FREDRA S.A.

5th Km. Pajanis –
Markopoulou Road
19400 Koropi, ATHENS
Tel.: (30.1) 60 20 500
Fax: (30.1) 62 27 748
E-mail: fredra@edra.gr
Contact:
Manos DIMITROPOULOS

Hong Kong

MENARD Representative
FULIGHT ENGINEERING LTD

Office n°507, 5F Tower 2
Silvercord, 30, Canton Road
Tsimshatsui, Kowloon
HONG KONG
Tel.: (852) 2398 1022
Fax: (852) 2787 4895
E-mail: peterlam@lapkai.com
Contact: Peter LAM BUI

Indonesia

MENARD Representative
PT FREYSSINET TOTAL
TECHNOLOGY

J.L. Prof Dr SUPOMO SH # 45B-C
JAKARTA 12810
Tel.: (62.21) 830 02 22
Fax: (62.21) 830 98 41
E-mail: ftt@freyssinet.co.id

Ireland

MENARD Representative
REINFORCED EARTH CO.

Industrial Estate -Newbridge
Co. KILDARE
Tel.: (353) 4543 1088
Fax: (353) 4543 3145
E-mail: reco_ireland@iol.ie
Contact: Martin GRACE

Italy

MENARD Representative
FREYSSINET TERRA ARMATA
S.P.A.

Via Giulio Vincenzo Bona, 101
00156 ROME
Tel.: (39.06) 41 87 71
Fax: (39.06) 41 87 72 01
E-mail: terra-armata@fretai.com
Contact: Giovanni MUCCIACCIA

Korea

SANGJEE MENARD

Room 609
Daejong Building, #143-48
Samsung Dong, Kangnam Gu
SEOUL
Tel.: (82.2) 58 79 286
Fax: (82.2) 58 79 285
E-mail:
masse@sangjee-menard.co.kr
Contact: Frédéric MASSE

Malaysia

MENARD GEOSYSTEM SDN BHD

N°27B, 2nd floor, Jalan USJ 10/1A
UEP Subang Jaya,
47620 Petaling Jaya - SELANGOR
Tel.: (60.3) 5632 15 81
Fax: (60.3) 5632 15 82
E-mail: menard@tm.net.my
Contact: Kenny YEE

Mexico

MENARD Representative
TIERRA ARMADA S.A. de C.V.

Gauss N°9 Despacho 301
Col. Anzures
C.P. 11590 MEXICO, D.F.
Tel.: (52.55) 5254 54 00
Fax: (52.55) 5254 86 65
E-mail: tierra_armada@infosel.net.mx

Netherlands

MENARD Representative TERRE ARMEE BV

P.O. Box 7220
4800 GE - BREDA
Tel.: (31.76) 531 93 32
Fax: (31.76) 531 99 43
E-mail: terarm@euronet.nl

Philippines

MENARD Representative JMA CORPORATION

Platinum 2000, Suite 303, 3rd floor
N°7 Annapolis Street, Greenhills
San Juan, METRO MANILLA
Tel.: (632) 727 3531
Fax: (632) 723 5928
E-mail: jma410@csi.com.ph
Contact: Johnny ARANETA

Poland

MENARD Representative FREYSSINET Polska SP.ZO.O.

Ul. Mala 5
05-822 MILANOWEK
Tel.: (48.22) 792 13 86
Fax: (48.22) 724 68 93
E-mail: info@freyssinet.pl
Contact: Krzysztof BERGER

Portugal

MENARD Representative TERRA ARMADA LDA

Rua Padre Américo, n°8-B
Escritorio 2
1600-548 LISBON
Tel.: (351.21) 716 16 75
Fax: (351.21) 716 40 51
E-mail: terraarmada@freyssinet.pt

Romania

MENARD Representative FREYROM S.A.

40-50, rue Chitila Triaj
Sector 1
BUCAREST
Tel.: (40.1) 220 35 50
Fax: (40.1) 220 45 41

Singapore

MENARD Representative REINFORCED EARTH (S.E.A.) PTE LTD

511 Kampong Bahru Road
05-06 Keppel Distripark
SINGAPORE 099 447
Tel.: (65) 272 00 35
Fax: (65) 272 93 53
E-mail: reco_singapore@pacific.net.sg
Contact: Alex WONG

South Africa

MENARD Representative REINFORCED EARTH PTY LTD

2nd floor, 1 Park Road Richmond
Cnr, Menton & Park Roads
RICHMOND 2092
JOHANNESBURG (Gauteng)
Tel.: (27.11) 726 6180
Fax: (27.11) 726 5908
E-mail: info@intekom.co.za

Spain

MENARD Representative FREYSSINET S.A.

C/ Melchor Fernandez Almagro, 23
28029 MADRID
Tel.: (34.91) 323 95 50
Fax: (34.91) 323 95 51
E-mail: freyssinet-pre@tierra-armada.com
Contact: Teresa PEREZ

Switzerland

MENARD Representative FREYSSINET S.A.

15 Postal 111
Z.I. Le Grand Pré
1510 MOUDON
Tel.: (41.21) 905 48 02
Fax: (41.21) 905 11 01
E-mail: freyssinet@bluewin.ch

Taiwan

MENARD Representative ASIA WORLD ENGINEERING & CONSTRUCTION (AWEC)

Far East World Center
7F-2, N°81, Sec 1, Tai wu Road
Hsichih
Taipei County,
TAIWAN, REPUBLIC OF CHINA
Tel.: (886.2) 2698 4988
Fax: (886.2) 2698 0202
E-mail: awec@awec.com.tw
Contact: Zue-Min HWANG

Thailand

MENARD Representative FREYSSINET THAILAND LTD

15th floor, Sethiwan Tower,
139 Pan road, Silom
BANGKOK 10500
Tel.: (66.2) 266 6088
Fax: (66.2) 266 6091
E-mail: freyssi@ksc.th.com

Turkey

MENARD Representative REINFORCED EARTH A.I.S.

c/o Zetas
Silahtarbahçe Sk
Soyak Sitesi Selamiali Mah
B7 Blok D1
81150 ÜSKÜDAR - ISTANBUL
Tel.: (90.216) 492 8424
Fax: (90.216) 492 3306
E-mail: reastr@veezy.com

United Arab Emirates

MENARD Representative FREYSSINET MIDDLE EAST LLC

PO Box 28752
ABU DHABI
Tel.: (971) 2 445 88 18
Fax: (971) 2 445 88 16
E-mail: freysnet@emirates.net.ae

United Kingdom

MENARD Representative REINFORCED EARTH COMPANY LTD

7 Hollinswood Court
Stafford Park 1
TELFORD TF3 3DE
Tel.: (44.1) 952 201 901
Fax: (44.1) 952 201 753
E-mail: info@recouk.com
Contact: Patrick NAGLE

USA-West

MENARD SOILTREATMENT

764N. Cypress St.,
Orange CA 92867
Tel.: (1.714) 288 84 47
Fax: (1.714) 639 87 01
E-mail: cspaulding@menardusa.com
www.menardusa.com
Contact: Charles SPAULDING

USA-East

DGI - MENARD

275, Millers Run Road
Bridgeville PA 15017-1321
Tel.: (1.412) 257 2750
Tel.: (800) 326 6015 (USA only)
Fax: (1.412) 257 8455
E-mail: dgi@wickdrain.com
www.wickdrain.com
Contact: James WARREN

Venezuela

MENARD Representative TIERRA ARMADA CA

Av El Parque Cruce/Av Andrés Bello
Edificio Oficentro Piso 5, Oficina 5-B
San Banardino
CARACAS
Tel.: (58.212) 574 90 38
Fax: (58.212) 574 77 50
E-mail: taca4@viptel.com

Vietnam

MENARD Representative FREYSSINET INTERNATIONAL ET CIE

Representative Office
2, rue Trieu Quoc Dat
HANOI
Tel.: (84.4) 826 14 16
Fax: (84.4) 826 11 18