



ENTEKO SOIL DISPLACEMENT METHOD

SOIL DISPLACEMENT METHOD

Enteco has developed a powerful line of piling rigs to execute the Soil Displacement (**SP**) drilling method. The technique has been developed to perform a low-impact, low-cost composite ground improvement system to densify and reinforce soft ground without causing vibration, minimizing concrete usage without generating spoils which is critical on brownfield sites.

Soil displacement piles are grouted columns that are installed using a large-torque, high crowd force rigs equipped with a special designed tool that displaces soil laterally, which increases density and load bearing capacity with minimal topsoil disturbance. As the drilling tool is extracted the void is pressure grouted to create a column that further stiffens the soil, creating the composite ground improvement system.

The system has been specially designed to limit ground liquefaction potential and total and differential settlement. The columns do not need to be rock-socketed nor do they need pile caps because they support footings or slabs on grade without a direct connection. It can be used for buildings, highway embankments, bridge abutments and large commercial/industrial applications where the slab weighs more than the structure.

Soil displacement typically range from 300 mm to 620 mm in diameter and placed from 10 to 28 meters deep.

Savings of cement can be 30% over a deep-pile foundation.

The installation of piling by displacement involves a drilling process which is vibration-free and quiet. It uses a special tool powered by an equipment of large torque capacity and high static down thrust. During drilling, it displaces the soil laterally and hence, compact the surrounding soil to form displacement column, thus minimize amount of spoil.

Once the required depth of installation is reached, cement grouting of the column takes place under controlled pressure (usually less than 5 bars) to ensure a perfect soil-cement grout contact. During the extraction of the displacing tool, continuous grouting under controlled pressure takes place. The result is a cement column shaft that is effectively bonded to the surrounding soil. During installation, the torque and the rate of penetration of the tool is closely monitored by means of electronic report systems similar to CFA recording systems.

Similarly, during the formation of the column, the rate of the tool extraction is controlled with respect to the cement grout mixture flow rate. A measuring gauge is used to maintain the supply of cement grout mixture which will also be used to indicate the column diameter with respect to depth.

SUITABLE TYPES OF SOIL FOR REINFORCEMENT TREATMENT

Soft cohesive soil is improved by consolidation (e.g. vertical drainage with surcharge fill) and it takes time to achieve the required degree of consolidation. Alternatively, ground reinforcement can be applied in soft soil to increase bearing support and provide stability in shorter time. Also, these reinforcement columns can reduce post construction settlement by a factor of 2 to 4. However, typical treatment depth is between 10 – 15m and in exceptional case it goes deeper than 20m.

The ratio of stiffness of Soil displacement to the surrounding soil is much higher. The stiffness modulus of SP is typically 5,000 MPa as compared with 30 – 80 MPa for non-rigid granular columns. SP is also used for anti-liquefaction treatment under seismic condition. The design of **SP** in this case incorporates the effect of volumetric strain on the surrounding soil and the increase shear resistance of the composite SP-soil mass to resist lateral displacement and shear stresses induced during a seismic event.

During installation, the displacement tool displaces the soil laterally without extraction of spoil and hence, increases the density of the soil which reduces the susceptibility of liquefaction. A volumetric strain of 4% in sand will result in an immediate compaction which increases the limit pressure by a factor of 2 and hence, it increases the bearing capacity accordingly.

Volumetric Strain	Improvement Factor		
	Sand	Silt	Clay
1%	1.3	1.2	1.1
2%	1.5	1.4	1.2
4%	2.0	1.6	1.3

SOIL DISPLACEMENT PILES BEARING CAPACITY					
PILE LENGTH	PILE DIA.	LATERAL	PEAK LOAD	BREAKING LOAD	TOTAL (F.S.=2.5)
m	mm	ton	ton	ton	ton
10	300	60	21	82	33
	400	79	28	107	43
	500	98	34	132	53
	600	117	41	158	63
12,5	300	75	26	102	41
	400	99	35	134	53
	500	123	43	165	66
	600	146	51	197	79
15	300	90	32	122	49
	400	119	42	160	64
	500	147	51	198	79
	600	175	61	237	95
17,5	300	106	37	143	57
	400	139	48	187	75
	500	172	60	232	93
	600	205	72	276	100
20	300	121	42	163	65
	400	158	55	214	86
	500	196	69	265	106
	600	234	82	316	126



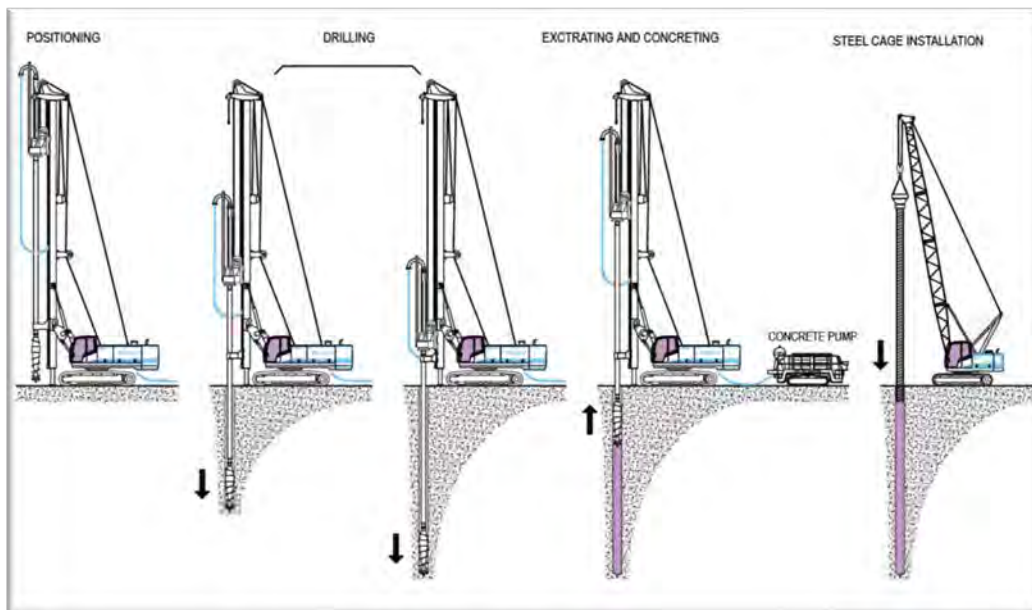
THE DRILLING METHOD

ENTEKO equipment are specially designed to be applied with SP (Soil Displacement) applications, with very advanced engineering solutions and innovative research, special patented tools to provide customers with high efficiency and high productivity rigs.

ENTEKO rigs with **SP** system are equipped with very powerful hydraulic rotary tables that are sliding along the drilling mast of the unit by means of a high performance winch capable to develop very high crowd and extraction force. A long single stroke drilling rod with hollow passage is attached at the bottom of the rotary to drive a special tool designed to lateral displace the soil of the drilled spot.

By drilling and crowding, the rod and the tool are penetrating the soil up to the designed drilling depth; concrete is then pumped through the hollow stem of the drilling rod to be released at the bottom of the tool by means of an opening cap. During concrete pumping operation, the drilling rod with the tool is withdrawn.

A steel reinforcement cage is then installed if required, by means of an auxiliary vibrator.



MAIN SP METHOD ADVANTAGES

- Neat job site with no bentonite and soil spoils disposal
- No vibrations and noise that makes the system highly recommended for inner city sites and where historic building and monuments are present
- Simplified job site set up with a limited number of machineries and personnel
- Concrete waste saving
- Full control of concreting parameters (pressure, timing, verticality etc.)
- High bearing capacity of the pile with reduced piles diameter
- High productivity
- Suitable for polluted areas

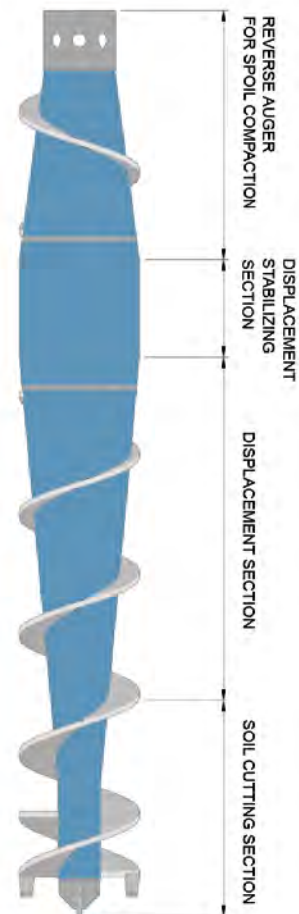
THE DRILLING TOOL FOR SP OPERATIONS

The designed drilling tool for **SP** operations is composed by a starting auger tip to penetrate the soil, a central body with oval shape to laterally compact the excavated soil and a top reverse auger top. The tool is connected to a string of hollow pipes connected by special made watertight joints. The concrete is pumped through the hollow pipes during extraction. Since the drilling tool is rotating during extraction, the reverse top auger has the function to further compact the collapsing spoils when extracting and concreting.

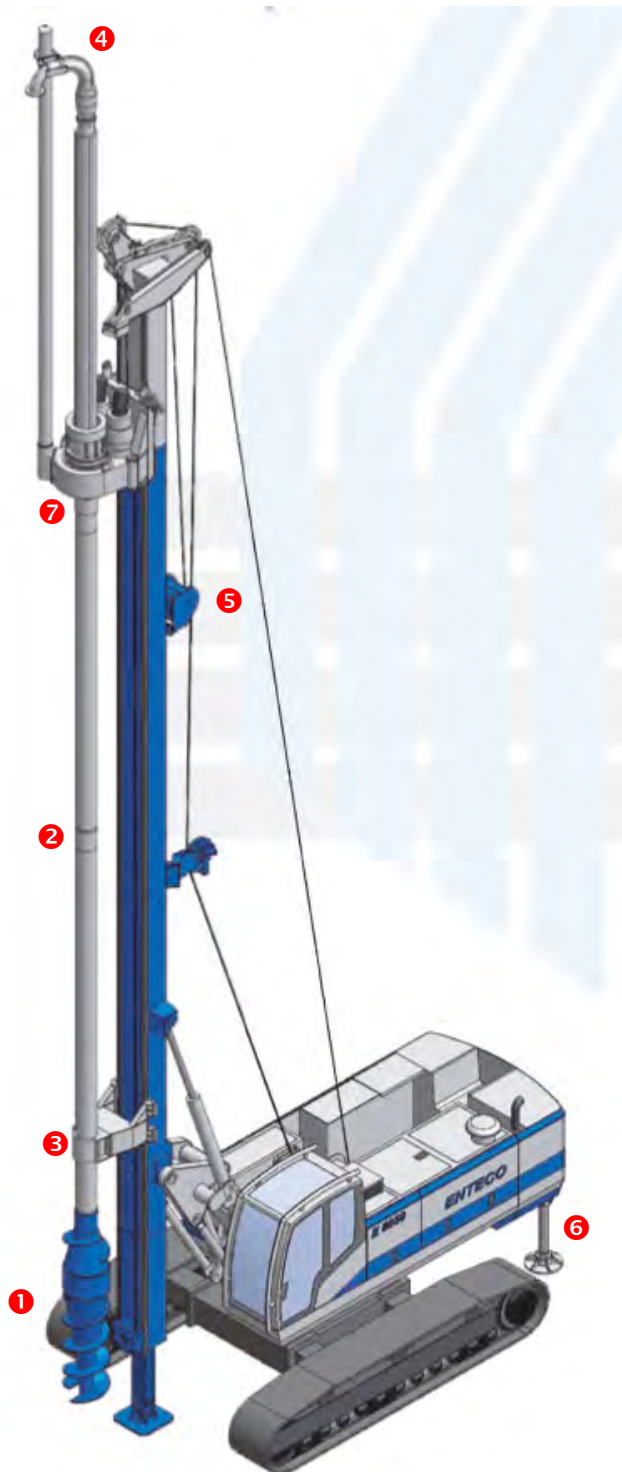
The bottom auger is provided with Enteco special design openings for concrete flowing.

The system of strings and tools is especially designed to prevent any contamination of the concrete from soil spoils and water.

SP piles can also be socked into hard strata layers (250-300kg/sqcm) since drilling tools tips are interchangeable and suitable to be equipped with cutting teeth for hard soil formations.



DRILL RIG DESCRIPTION



- ① DRILLING TOOL
- ② HOLLOW PASSAGE RODS
- ③ CENTERING GUIDE
- ④ CONCRETING SWIVEL
- ⑤ CROWD WINCH
- ⑥ REAR STABILIZERS
- ⑦ HIGH TORQUE ROTARY



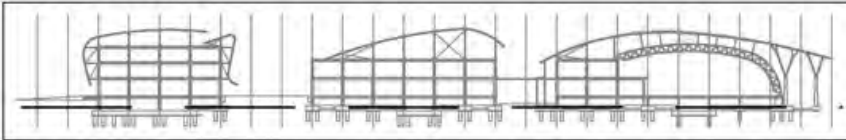
ENTEKO RIGS

Monselice – Este New Medical Hospital

25.000 meters of foundation piles have been drilled by ENTEKO rigs for the construction of the new Monselice – Este medial hospital complex. 620 mm diameter soil displacement piles have been made with E6040 and E6050 Enteco rigs.



KEY - SECTION



ENTEKO E6050 MODEL EQUIPPED WITH SOIL DISPLACEMENT APPLICATION

ENTEKO high productivity hydraulic rig **E6050 equipped with Soil Displacement (SP) attachment** has been selected for a very challenging job in Monselice, a historical town in Veneto - Italy, nearby the main cities of Venice and Padua where a new medical hospital complex project was located.

The area of Monselice is very well known since year 1400 for its quarries of trachyte stones, mainly used to embellish venetian palaces.

The soil composition, in the area where the soil displacement piles have been drilled, is formed by a layer of clay and sand loams.

Between -18 and -24 meters from the ground level surface, high density sand layers with variable hardness from 200 to 300 Kg/cm² (20-30 M Pa) are encountered.

SPT tests reported an average value of 45 Nspt.

About one third of the drilled piles have been designed also as **geothermal** pits to provide climate control for the hospital complex.

The construction procedure has been designed to apply geothermal pipes 1" diameter to house heating pumps and placed in operation before placing the reinforcement cages inside the pile.



ENTEKO MODEL E6050

- ROTARY TORQUE 245 KNM
- DRILLING DEPTH 25 METERS
- CROWD FORCE 200 KN
- ENGINE POWER 261 KW
- OPERATING WEIGHT 50 TONS

HIGH PRODUCTIVITY RIG

The average production timing per pile including drilling, concreting and placing of steel reinforcement has been 15 minutes for 15 meters depth displaced piles and 30 minutes for 24 meters depth piles.

The daily production has been approximately 400 meters per working shift (8 hours).



SOIL DISPLACEMENT METHOD

ENTEKO equipment are specially designed to be applied with **SP** (Soil Displacement) applications, with very advanced engineering solutions and innovative research, special patented tools to provide customers with high efficiency and high productivity rigs.

Enteco can provide SP applications for piling up to 1000 mm diameter to a single stroke depth of 46 meters.

ENTEKO rigs with SP system are equipped with very powerful hydraulic rotary tables that are sliding along the drilling mast of the unit by means of a high performance winch capable to develop very high crowd and extraction force.

A long single stroke drilling rod with hollow passage is attached at the bottom of the rotary to drive a special tool designed to lateral displace the soil of the drilled spot.

By drilling and crowding, the rod and the tool are penetrating the soil up to the designed drilling depth; concrete is pumped through the hollow stem of the drilling rod to be released at the bottom of the tool by means of an opening cap. During concrete pumping operation, the drilling rod with the tool is withdraw.

A steel reinforcement cage is then installed if required, by means of an auxiliary vibrator.

Soil displacement piles can be also performed with the LB (Lost bit) technique: in this case the reinforcement cage is installed inside the hollow stem of the drilling rod before concreting. After concreting the steel cage and the concrete are released at the bottom of the displaced pile by releasing the bottom of the tool that is left inside the pile.

A specially designed tool can be also provided to perform MF soil displacement piles: this system is based on the displacement of the soil to design a screw flight profile in the soil. By this system the friction of the soil with the concrete is increased.

SOIL DISPLACEMENT APPLICATION FIELD

- MUD, CLAY AND SAND, LOOSE OR MEDIUM DENSE FORMATIONS
- POSSIBILITY TO SOCKET INTO FRACTURED ROCK

SOIL DISPLACEMENT ADVANTAGES

- NO MATERIAL DISPOSAL WITH NO MATERIAL DISPOSAL COSTS, IDEAL FOR POLLUTED SITES
- FASTER PRODUCTION COMPARED TO KELLY AUGER PILES
- NO FLUIDS TO SUSTAIN THE PILE ARE REQUIRED
- NO VIBRATIONS OR NOISE PRODUCED
- FULL CONTROL OF EXECUTED PILE FEATURES BY MEANS OF ELECTRONIC DEVICES
- DATA RECORDING OF THE PILE AND GRAPHIC RENDERING



ENTEKO PILING RIGS RANGE FOR SOIL DISPLACEMENT APPLICATION					
Series Model	Torque max	Depth max	Diameter max	Crowd Force	Extraction Force
	kNm	m	mm	kN	kN
E 9070 SP	275	32	600	280	760
E 9080 SP	320	35	800	330	870
E 9100 SP	400	38	800	400	1000
E 9140 SP	570	46	1000	500	1500
E 7050 SP	245	32	620	200	530
E 7080 SP	300	36	800	300	840
E 6040 SP	150	19	620	150	450
E 6050 SP	245	25	620	200	530

ENTEKO: EXPERIENCE AND INNOVATION

Based on this simple principle of excellence and on its long term experience in Foundation Equipment, **Enteco** offers reliable and innovative products, fast and efficient after sales service and professional business relations. Our Company is specialized in offering each Client the most suitable solution to meet demanding and challenging job site requirements through a wide range of foundation equipment designed and manufactured by Enteco in Italy.

PRODUCTS

Enteco manufactures a wide range of foundation equipment to comply with the needs of modern Contractors:

- **Drilling rigs for large diameter piles, from 25 up to 200 Ton operating weight**
- **Rigs equipped with Kelly Auger, CFA, Soil Displacement, Double rotary and Soil Mixing.**
- **Pile Driving equipment.**
- **Large diameter DTH piles equipment.**
- **Equipment for diaphragm walls.**
- **Heavy duty crawler cranes from 18 to 200 ton lifting capacity.**
- **Crawler drills for micro-piles and jet-grouting.**
- **Equipment for tunnel consolidation.**
- **Equipment for special foundation techniques.**

INNOVATION

Enteco Design and Engineering Department is a team of creative and skilled engineers provided with a wide technical knowledge and a strong will to co-operate with Customers, as our company is constantly looking for improvements and new solutions to supply innovative, simple, safe and reliable equipment. **Enteco** rigs are manufactured according to the highest quality control procedures with selected parts and components.

SERVICE AND SUPPORT

Enteco Service Engineers always assist Clients for the commissioning of the equipment on site and for supporting Customers to minimize maintenance timing. A comprehensive inventory of spare parts and components assures prompt deliveries worldwide. Specific training courses are regularly held to instruct operators and technicians, as well as to provide dealers with the most up-to-date information on equipment. **Enteco** presence is well established in many Countries around the world through professional and competent dealers willing to serve and co-operate with Clients.