DEVELOPMENT OF PROJECTS OF ENERGY GEOSTRUCTURES

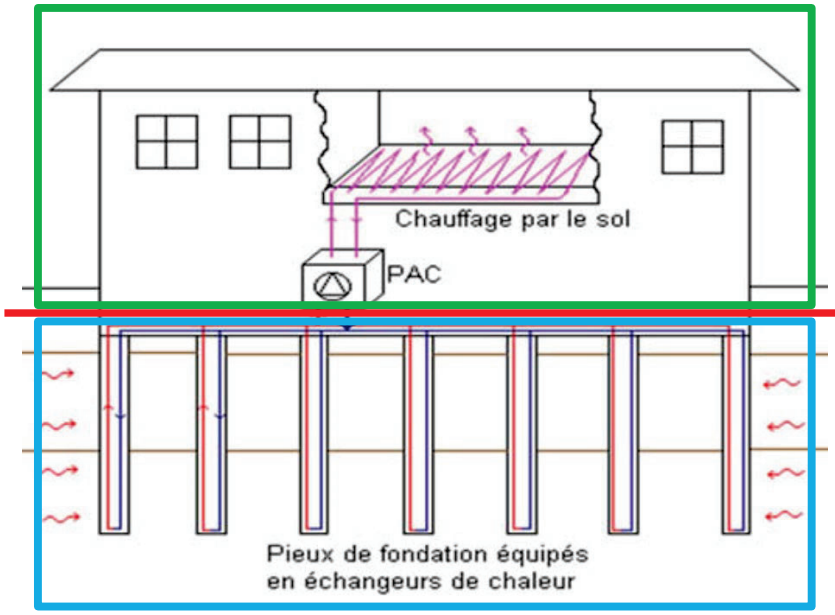
Energy Geostructures
EPFL, 6 May 2025

AGENDA

1. General concept
2. Equipment of steel reinforcement cages
3. Execution of piles (depending on pile system)
4. Pile cut-off
5. Laying of horizontal tubes
6. Manifolds mounting
7. Diaphragm walls execution
8. Challenges
9. Controls
10. Conclusion
11. References
12. Questions

GENERAL CONCEPT

The plant has 3 different parts:



Standard Part with a heating pump

Link = collector / manifold

Specific part to energy geostructures
- Energy piles
- Horizontal tubes

PROBLEM'S DATA

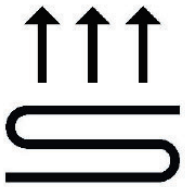
Example (built in 2018) :

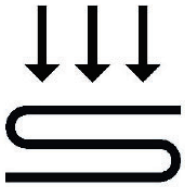
- **Industry hall in Yverdon-les-Bains**
- **Situation : Y-Parc (industry area «Yverdon Sud»),**
- **Intended use: manufacture of high precision measurment instruments**
- **Ground surface: ~1'630 m², 3 floors, no basement**

PROBLEM'S DATA

1. energy needs calculated by the heating engineer:

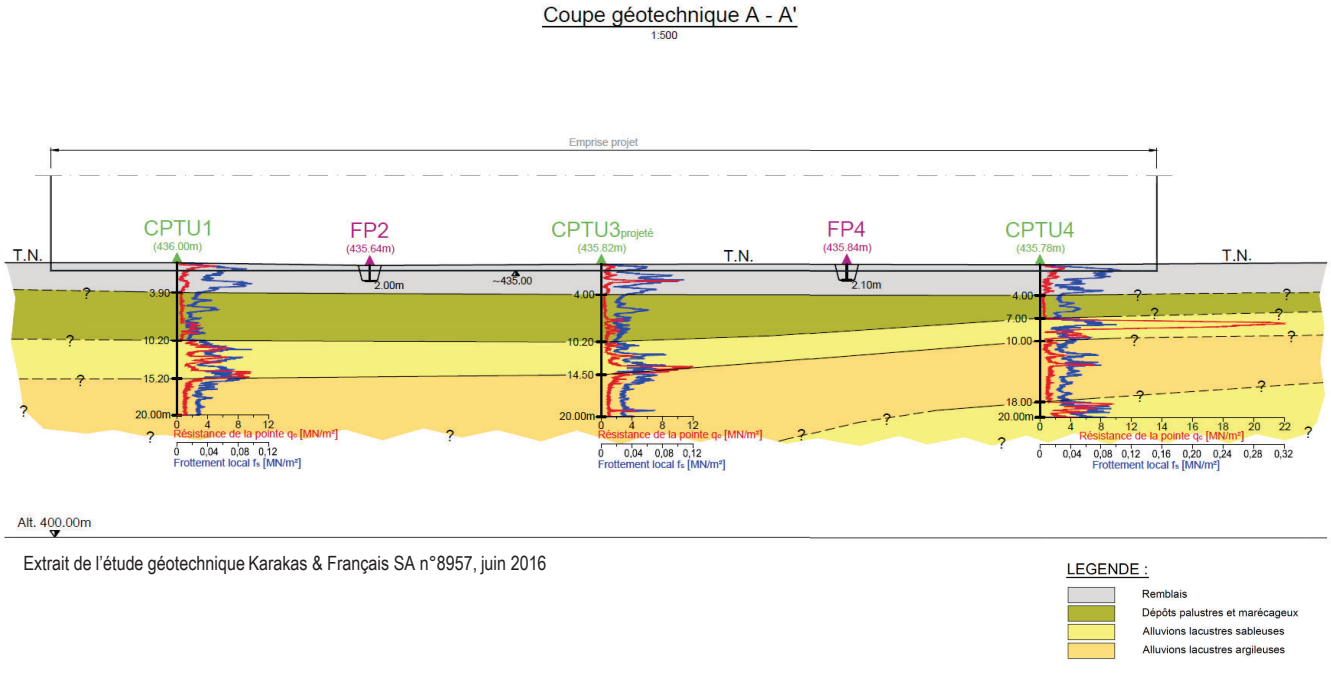
- The total energy input required to heat the building and produce domestic hot water is approx 376'000 kWh/year,
- The power that must be dissipated by cooling systems (out of scope) is approx 186'000 kWh/year,
- Energy produced by the dissipation process is from 48'400 kWh/year, so 22 kW 6h/day. Used to reload E-piles.





PROBLEM'S DATA

2. A subgrade acknowledged by the geologist



Extrait de l'étude géotechnique Karakas & Français SA n°8957, juin 2016

PROBLEM'S DATA

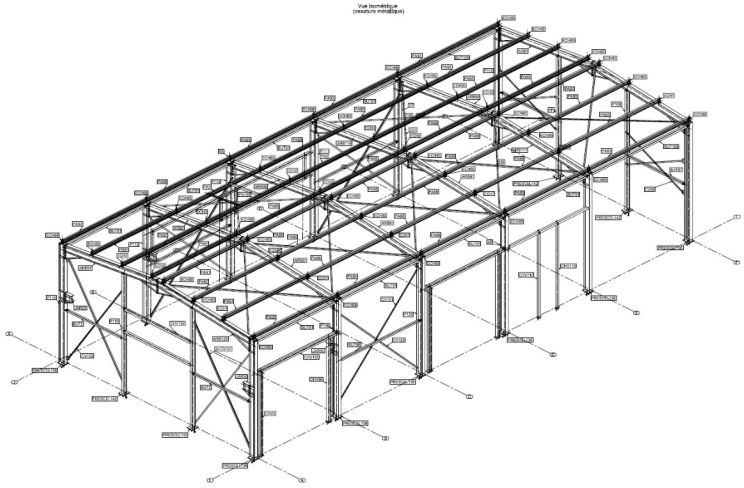
The geology of the site influences :

- **Plant performance. Type of soil, presence of a water table. Soil performance can be measured using a TRT test,**
- **The pile installation system.**

Adequate knowledge of the soil is an essential prerequisite for preparing a project.

PROBLEM'S DATA

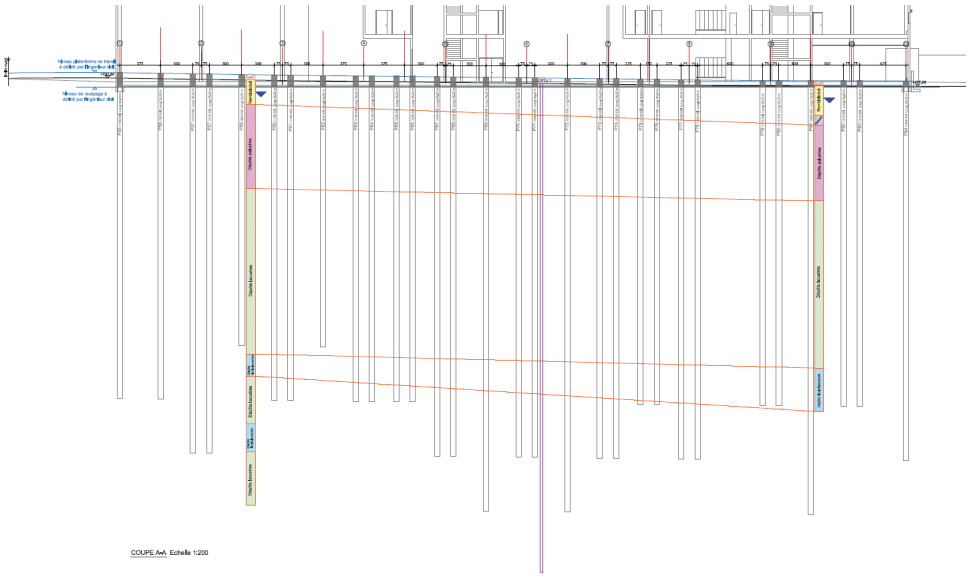
3. **A structure calculated by the civil engineer. The position of the piles is given/imposed by the static system selected.**



Source non identifiée.

PROBLEM'S DATA

4. A number and lengths of piles calculated by the geotechnical engineer.

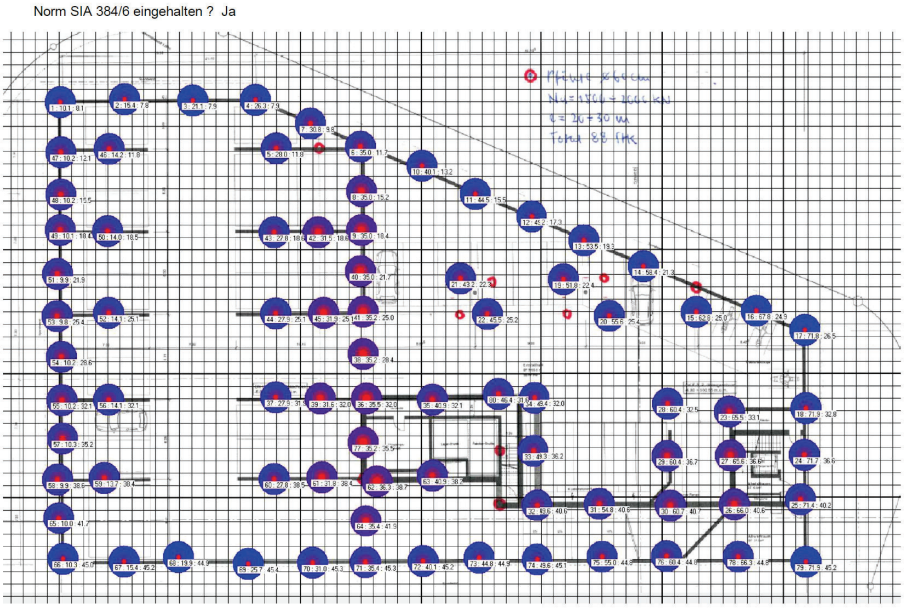


Extrait du plan n°2321-1 établi par Ybr Géologues SA

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

PROBLEM'S DATA

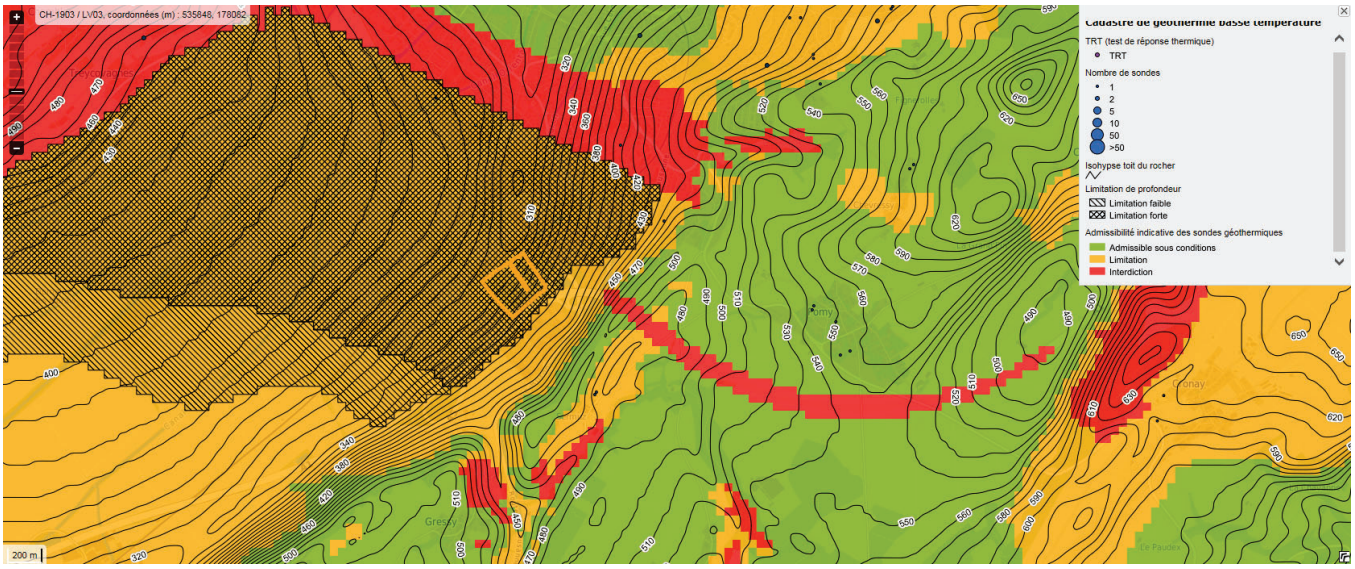
5. We can't equip every pile. A certain distance must be maintained to avoid interactions between the piles. This reduces the efficiency of the installation..



Neubau Stucasa AG, Heimberg, Enercret AG.

PROBLEM'S DATA

6. **Legal constraints: geothermal drillings authorised, depth highly limited.**



Source : Guichet cartographique de l'Etat de Vaud, capture d'écran du cadastre géothermique basse température dans la région d'Yverdon

RESPONSE TO THE PROBLEM (IN 2018)

Is a compromise that must take into consideration all constraints.

- **105 piles (3'500 m) including 86 energy piles**
- **Heating power evaluation : ~200'000 kWh/year so ~55% of the needs**

TRT TRIAL (THERMAL RESPONSE TEST)

Item : structure pile n°96, total length 40 m including 35 m equiped for heat exchange with 2U connected in series.

time : May 23 to july 10 2018.

Test fixture:

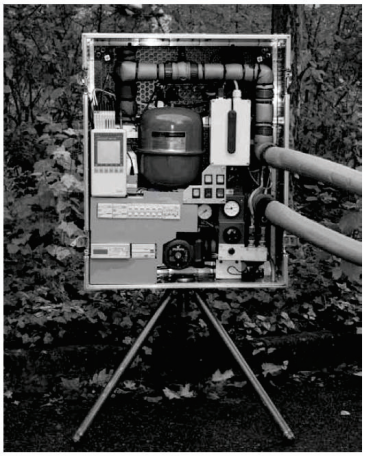


Figure 2-4: The EPFL mini-module.

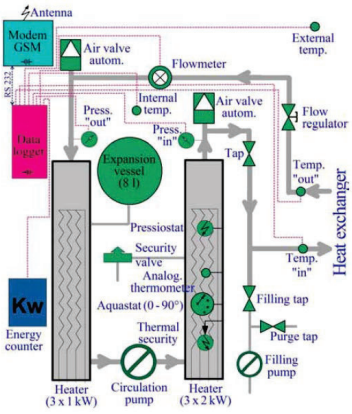


Figure 2-5: Schematic diagram of the EPFL mini-module.

Source : EPFL, Innovative Improvement of Thermal Response Test, Décembre 2008

Main results:

Paramètres	P96
Température moyenne du terrain sans chauffage T_0 [°C]	12.35 ± 0.2
Conductivité thermique moyenne du terrain λ_k [W/m.K]	1.89 ± 0.13
Résistance thermique moyenne de la sonde $R_{b,k}$ [K/(W.m)]	0.093 ± 0.019

Source : De Cérenville Géotechnique SA, Rapport d'essai de pieu géothermique, FD M14'069-1, juin 2018.

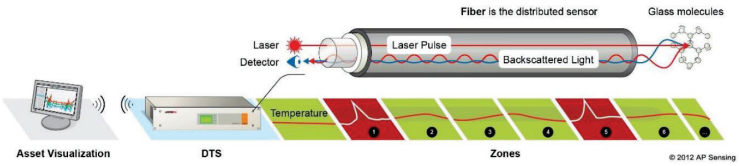
ETRT TRIAL (EXTENDED THERMAL RESPONSE TEST)

Measure with Optical Fiber.

Source : Enercret AG / Marti Gründungstechnik AG, Bussigny, QoQa SA, September – October 2019

ETRT TRIAL (EXTENDED THERMAL RESPONSE TEST)

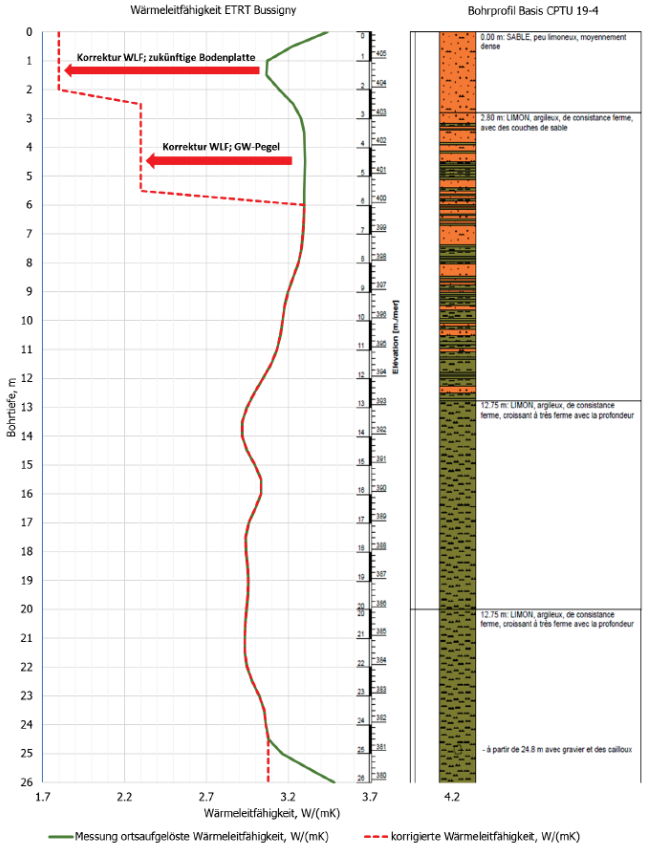
light diffraction changes with temperature.



possibility to measure every 50 cm.

possible comparison with geological layers.

Main results:

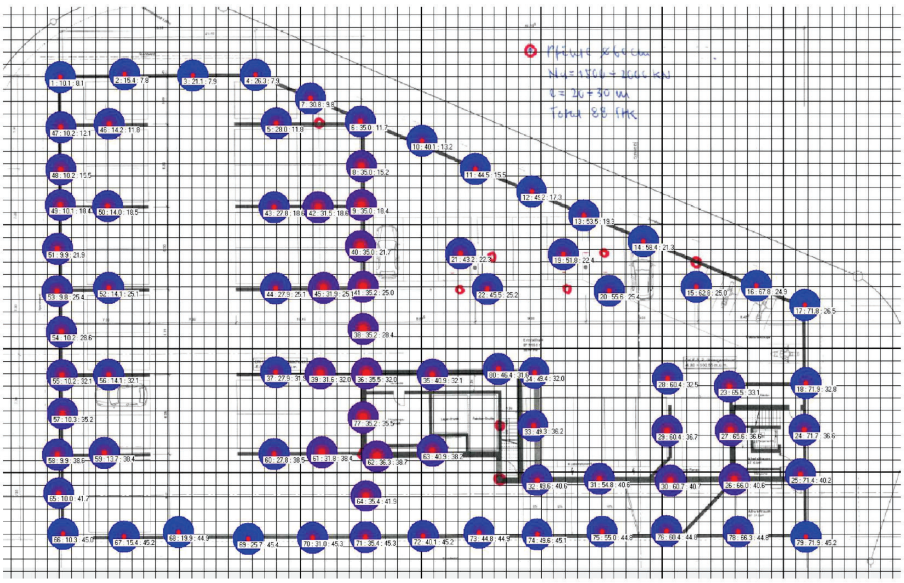


Source : Enercret AG / Marti Gründungstechnik AG, QoQa Bussigny, September – October 2019

OPTIMIZED RESPONSE TO THE PROBLEM

With the results of the TRT test, which gives the power per m1 that can be extracted, and the project data (position of the piles and length of the piles), it is possible to design the installation in accordance with the standards (SIA 384/6).

Norm SIA 384/6 eingehalten ? Ja



Neubau Stucasa AG, Heimberg, Enercret AG.

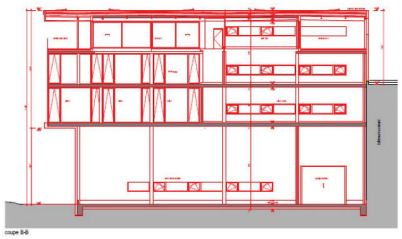
OPTIMIZED RESPONSE TO THE PROBLEM

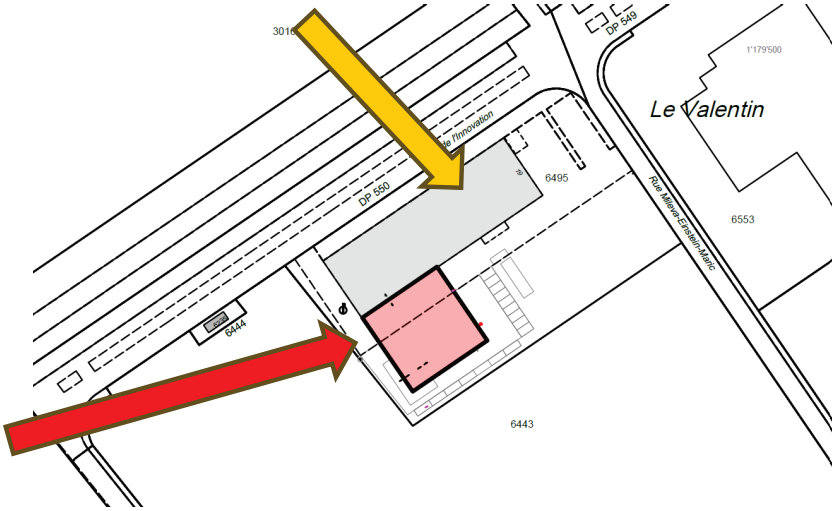
An optimization of the operation based on a simulation of the operation for 50 years.

Afford to keep the following data :

Projeté		Réalisé	
Energie annuelle extraite en chauffage [kWh]	Energie annuelle injectée en refroidissement [kWh]	Energie annuelle extraite en chauffage [kWh]	Energie annuelle injectée en refroidissement [kWh]
200'000	à définir	267'000 + 34%	165'000
Pourcentage de l'énergie de chauffage provenant de la géostructure + PAC [-]		Pourcentage de l'énergie de chauffage provenant de la géostructure + PAC [-]	Pourcentage de l'énergie de refroidissement injectée dans la géostructure [-]
55%		71% + 29%	87%

ALREADY BUILT IN 2018...

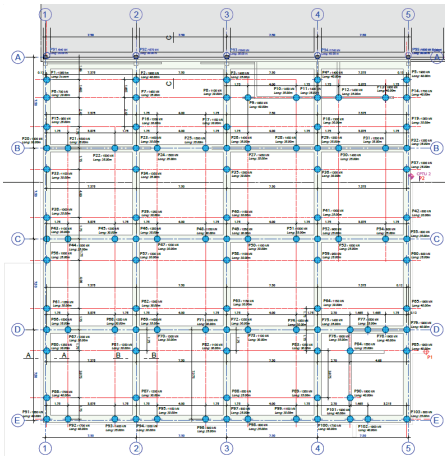




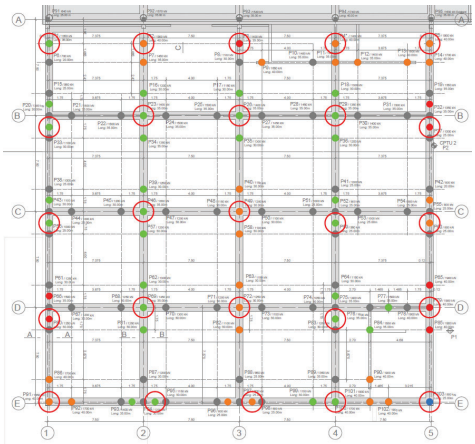
Will be built in 2025 :

Ground surface: ~900 m², 4 floors, no basement

USE OF DATA COLLECTED IN 2018...



- fewer, longer piles,
→ increased power



First sketch :

105 piles

25 E-piles (~750 m1)

Optimised project :

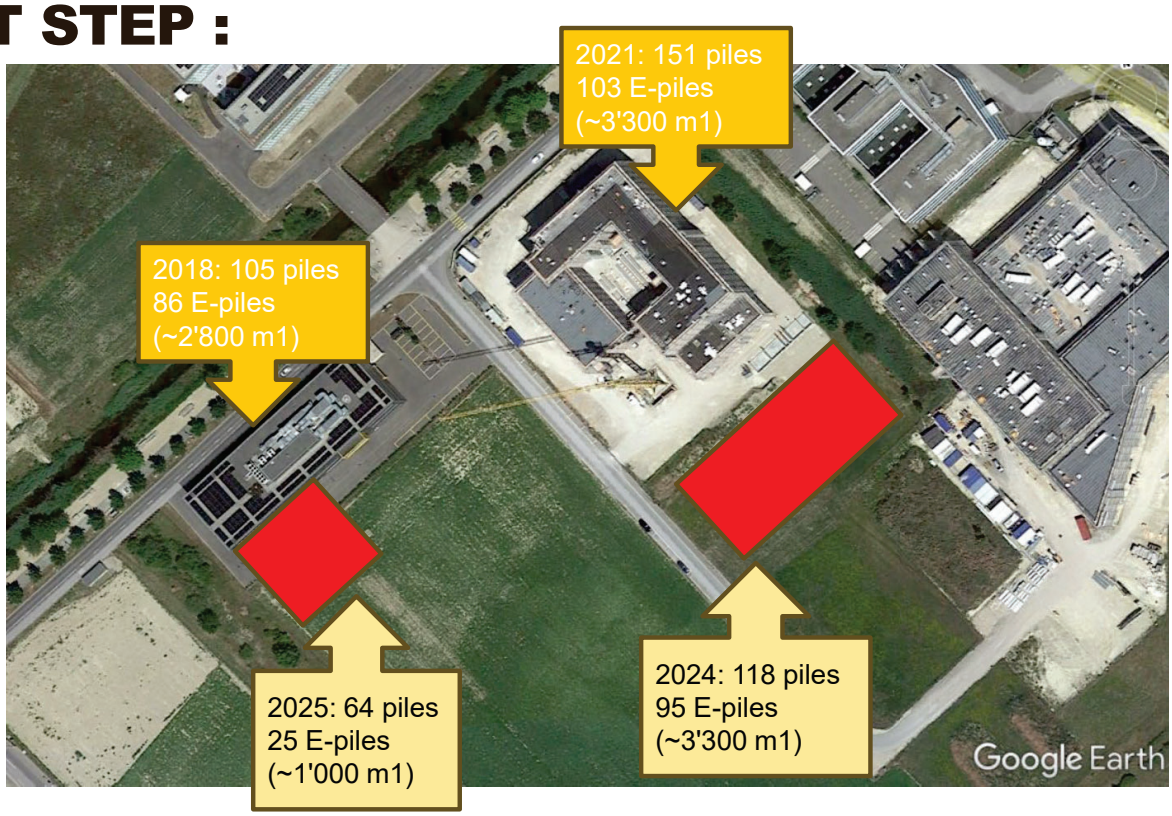
64 piles

25 E-piles (~1'000 m1) +25%

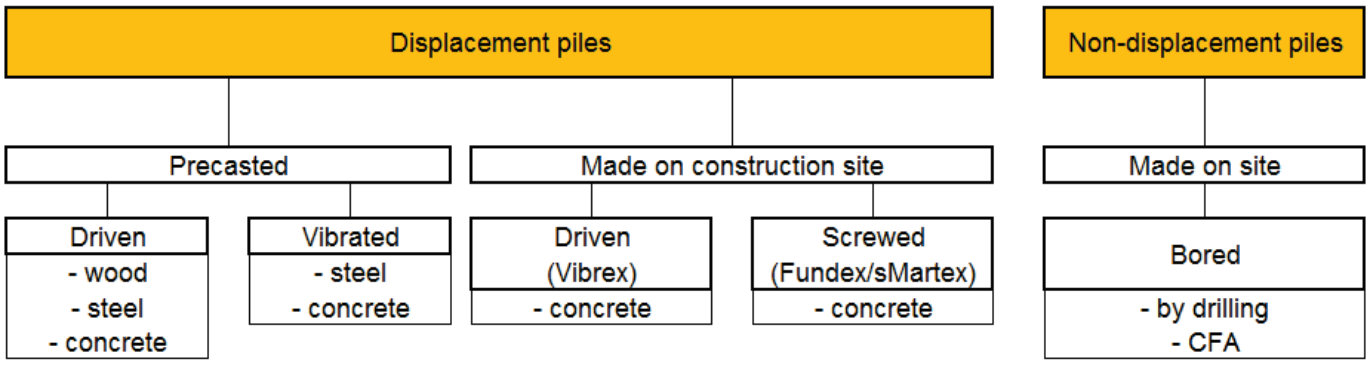
Optimisation of the plant's construction system.

The heating engineers who designed the plant regretted the lack of data on the operation of the heating system built in 2018. Consumption curves, seasonal average values, peak values, etc.

NEXT STEP :



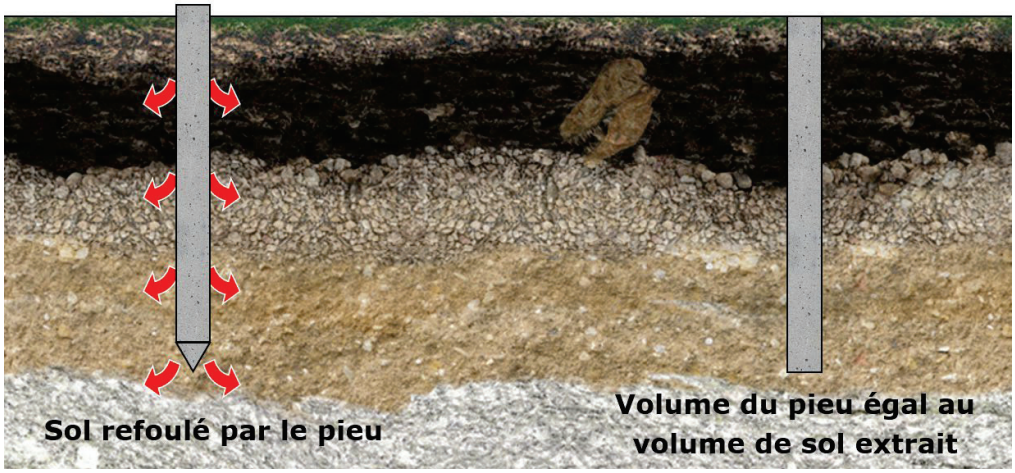
TYPES OF PILES



TWO TYPES OF IMPLEMENTATION

By upsetting, the ground is pushed back by the pile

By drilling, the ground is excavated



Source : V. Labiouse, EPFL - LMR, cours travaux de fondation, édition 2006.

Possible in soft to middle ground

Adapted to hard grounds, rock

DIFFERENCES WITH STANDARD PILES

1. **The cage must be set in the pile in one piece. Mounting tubes take a lot of time (electrowelded connectors),**

   - steel cages must be prepared and E-tubes must be controlled (weldings),

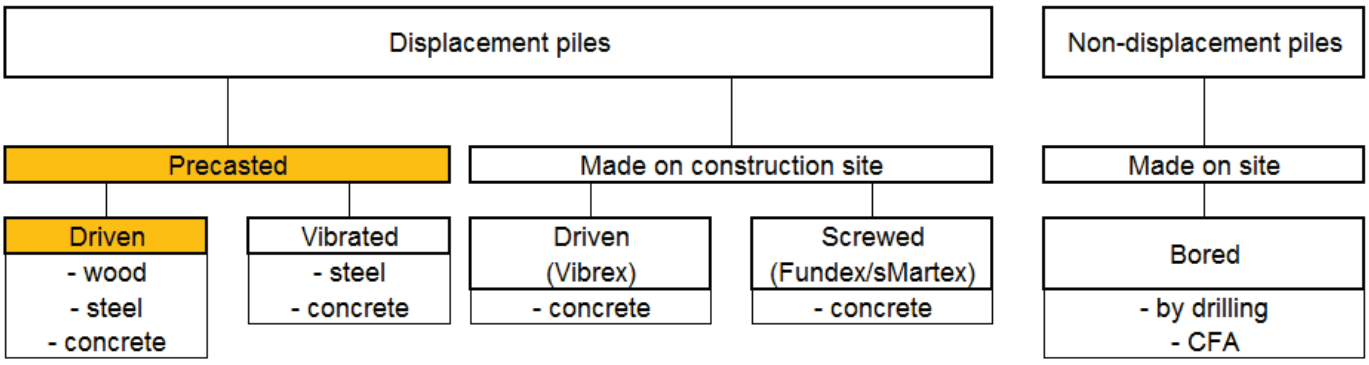
   - get the right cage at the right place (handling/logistic),

   - handling must be careful (risk to damage tubes and collapse the cage),

   - concreting work must be careful (protection of the tubes).

2. **Caution is needed during cut-off of the head of the pile, at the end of earthwork.**
3. **Set up of tubes from piles to collectors (coordination).**

PRE-FABRICATED AND RAMMED PILES



PRE-FABRICATED AND RAMMED PILES

Pre-casted concrete tubes set up by beating

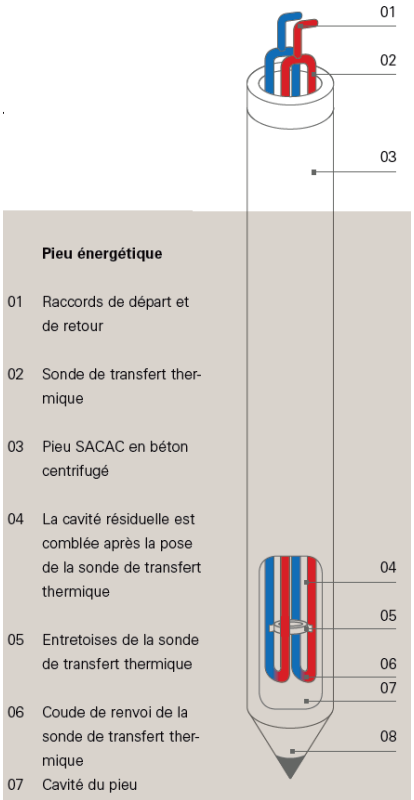
Source : documentation SACAC SA, www.sacac.ch

PRE-FABRICATED AND RAMMED PILES

energy tubes are threaded in the inner void after beating.

Void is afterwards filled with concrete to seal those.

Source : documentation SACAC SA, www.sacac.ch



Pieu énergétique

01 Raccords de départ et de retour

02 Sonde de transfert thermique

03 Pieu SACAC en béton centrifugé

04 La cavité résiduelle est comblée après la pose de la sonde de transfert thermique

05 Entretoises de la sonde de transfert thermique

06 Coude de renvoi de la sonde de transfert thermique

07 Cavité du pieu

08 Pointe du pieu

PRE-FABRICATED AND RAMMED PILES

Benefits

- fast and economic
-potential titled implementation
- bearing capacity verified during implementation
- possible execution under protected water table
- ground push down, favorable for bearing capacity
- very easy energy equipment

Limits

- concrete heavy components, complex transport and handling
- welded connections between elements
- damage risk (head/foot)
- disturbance (noise and vibrations)
- impossible passing of obstacles (rock block)

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

PRE-FABRICATED AND RAMMED PILES

Prefabricated driven piles are rarely used in Switzerland.

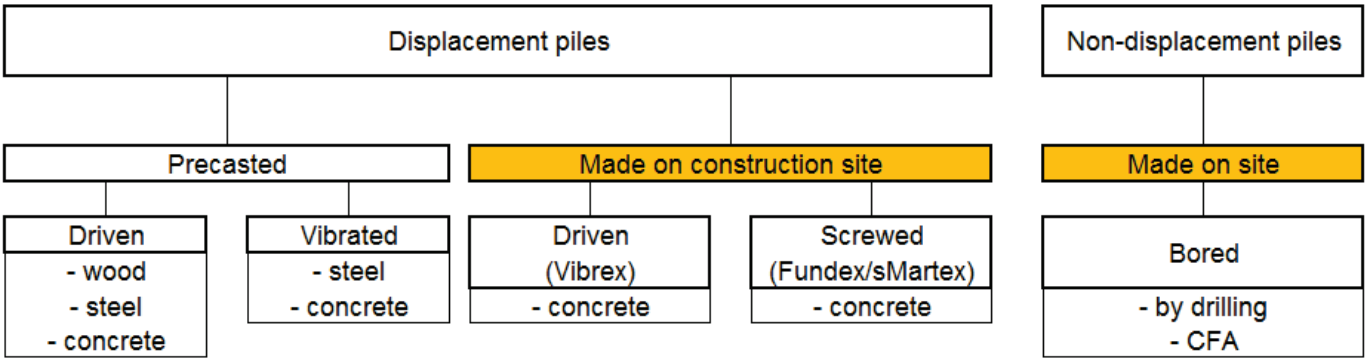
They are mainly used :

- in water protection zones S,
- for very small projects.

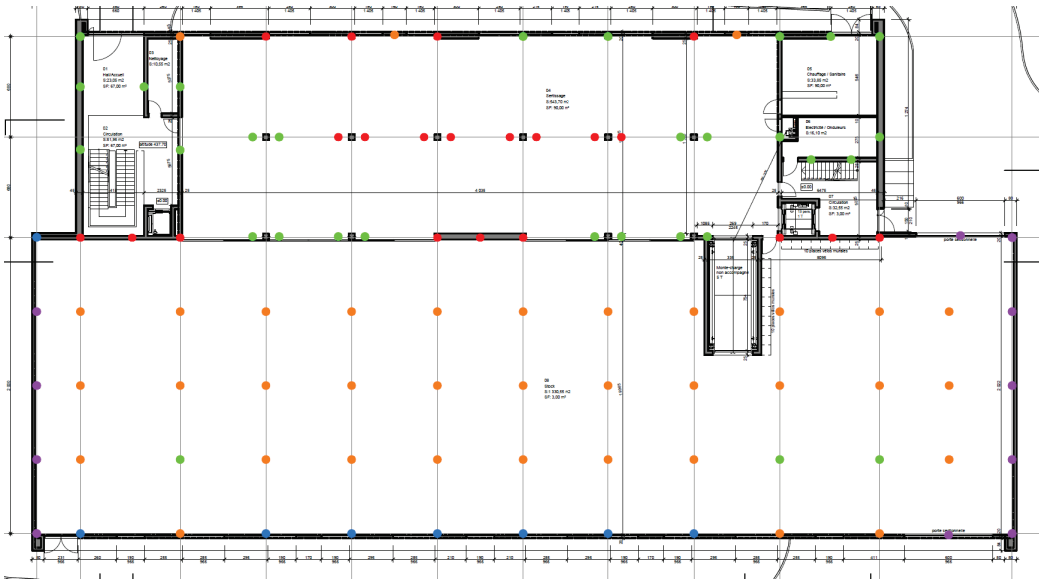
To our knowledge, there are only two installations in Switzerland.

One was built by us in Valais.

PILES MADE ON SITE : COMMON TOPICS

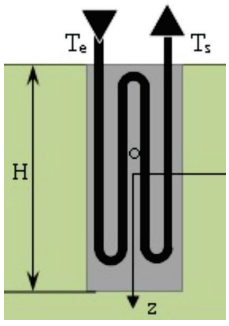


CAGE EQUIPMENT ON CONSTRUCTION SITE



● sMartexscrew ø550, L=20 m (11 p.)
● sMartexscrew ø550, L=25 m (8 p.)
● sMartexscrew ø550, L=30 m (36 p.)
● sMartexscrew ø550, L=35 m (30 p.)
● sMartexscrew ø550, L=40 m (21 p.)

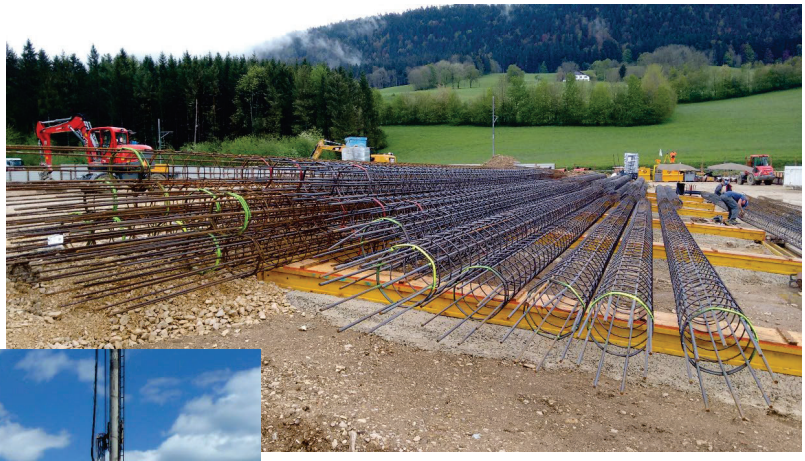
Preparing energy piles



CAGE EQUIPMENT ON CONSTRUCTION SITE

An installation site is built on the construction site.

A colour code is adopted do differentiate cages typ / length.



Length of cages is usually between 20 and 35m.

It can be up to 44m.

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

CAGE EQUIPMENT ON CONSTRUCTION SITE

Introducing tubes in the steel cage.

CAGE EQUIPMENT ON CONSTRUCTION SITE

Fixing tubes in the steel cage.

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

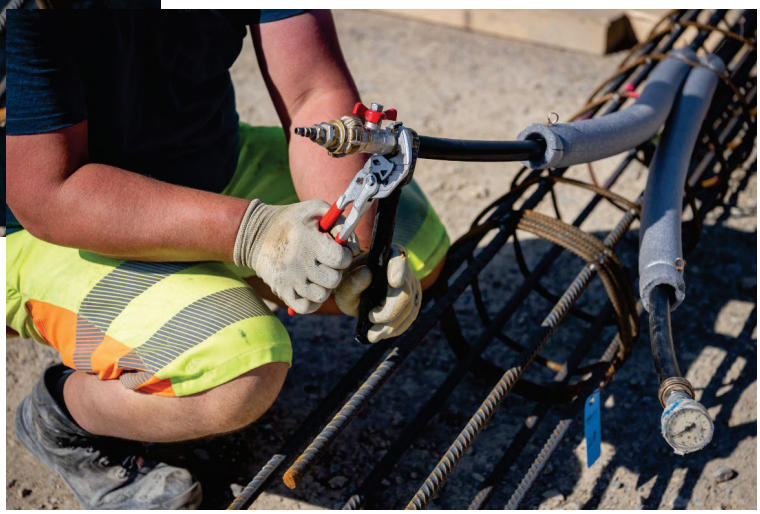
CAGE EQUIPMENT ON CONSTRUCTION SITE

Welding elements.

All the pieces have a barcode. This allows control and traceability. We know which piece is where, at what time it was welded and by whom.

CAGE EQUIPMENT ON CONSTRUCTION SITE

Fix the pressure gauge…



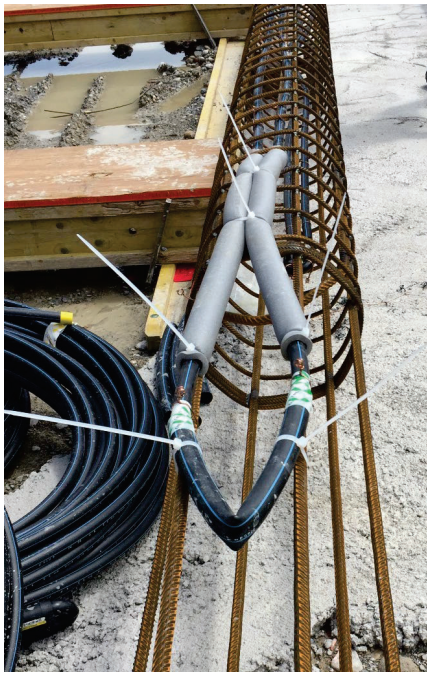
…Fix the valve.

CAGE EQUIPMENT ON CONSTRUCTION SITE

At the end of assembly all the cages are tested with air under a pressure of 8 bar.

CAGE EQUIPMENT ON CONSTRUCTION SITE

After pressure test pressure gauge and valve are protected.

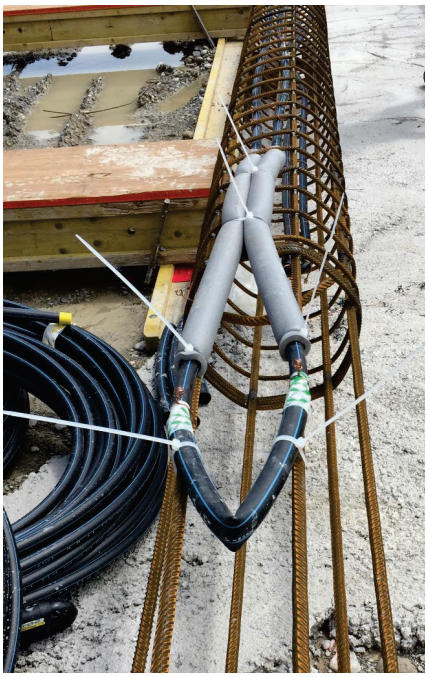


CAGE EQUIPMENT ON CONSTRUCTION SITE

energy tubes are built and tested on site.

Photos : Enercret AG, www.enercret.ch

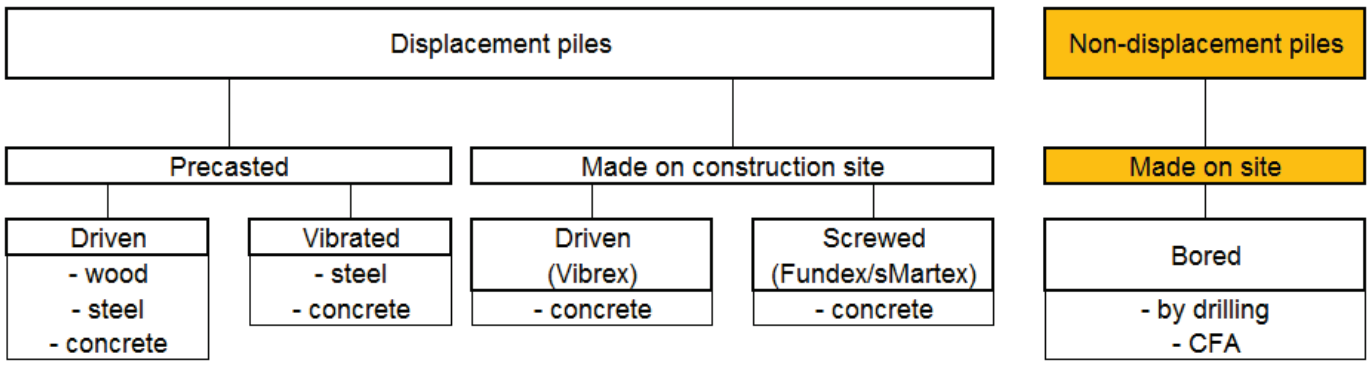
Detail of the base (2U).



Protected top of the tubes.

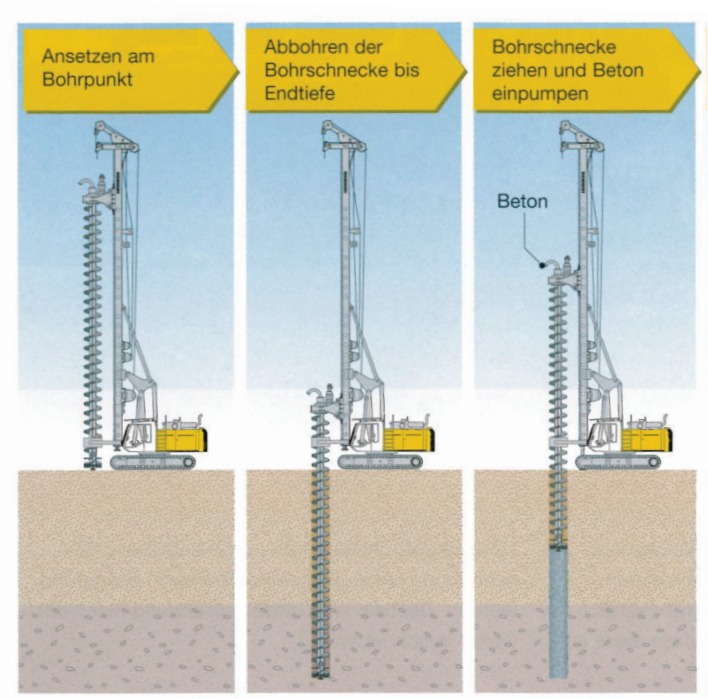
STEEL CAGE READY

TYPES OF PILES



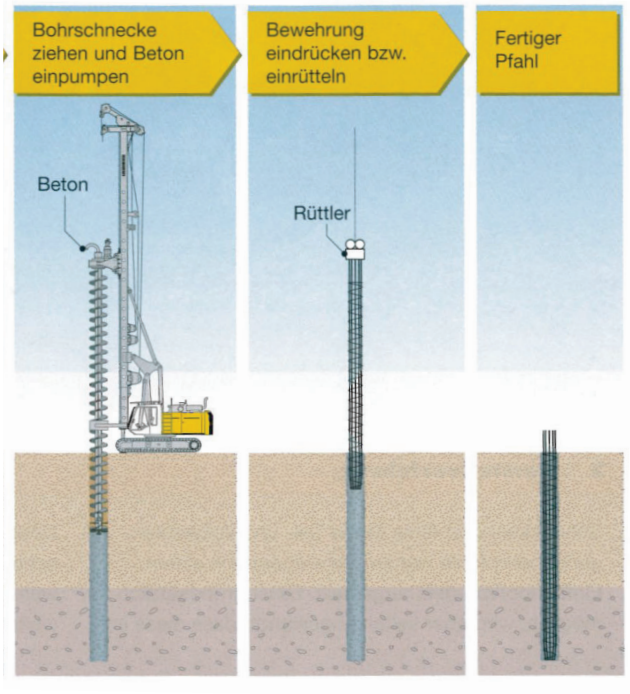
CONTINUOUS FLIGHT AUGER SYSTEM (CFA)

1. **The machine is positionned on the pile,**
2. **The auger is screwed in the ground up to the forecast depth,**
3. **The auger is slowly bring up by rotating. Simultanously, concrete is injected…**



Source : Spezialtiefbau: Kompendium Verfahrenstechnik und Geräteauswahl. Set Band I und Band II, Liebherr-Werk Nenzing GmbH, Ausgabe 2009.

CONTINUOUS FLIGHT AUGER (CFA)



3. **…under pressure in order to avoid create a hole in the concrete,**
4. **The steel cage is driven into the fresh concrete by using a vibrator the cage is dropped down,**
5. **Pile is ready.**

Source : Spezialtiefbau: Kompendium Verfahrenstechnik und Geräteauswahl. Set Band I und Band II, Liebherr-Werk Nenzing GmbH, Ausgabe 2009.

CONTINUOUS FLIGHT AUGER (CFA)

benefits

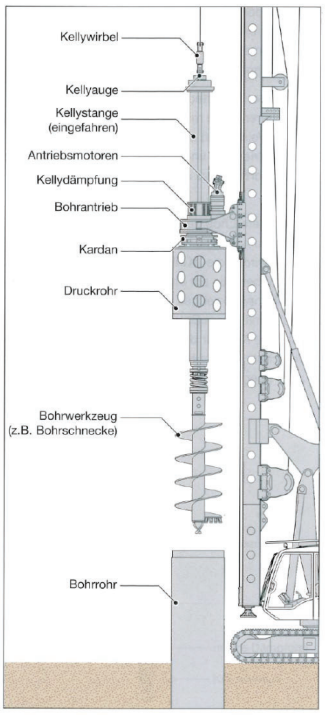
- screwed pile, few noise, no vibrations,
- possibility to measure the resistance on the tool,
- control on extracted ground,
- high efficency.

limits

- only possible in soft to average grounds,
- impossible obstacle passage,
- it is not always doable to drive the cage down into fresh concrete at the expected depth (difficulties starting at 15 – 20 m),
- length of energy tubes is challenging to guarantee (cage sinker)
- high risk to damage the cage during sinker.

DRILLS (KELLY + AUGER / BUCKET)

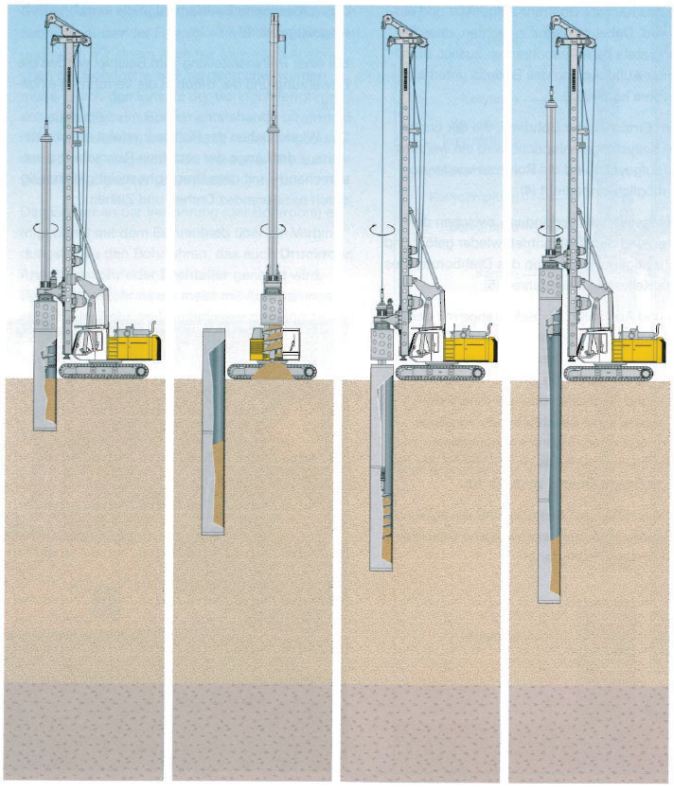
Most common approach.



Source : Spezialtiefbau: Kompendium Verfahrenstechnik und Geräteauswahl. Set Band I und Band II, Liebherr-Werk Nenzing GmbH, Ausgabe 2009.

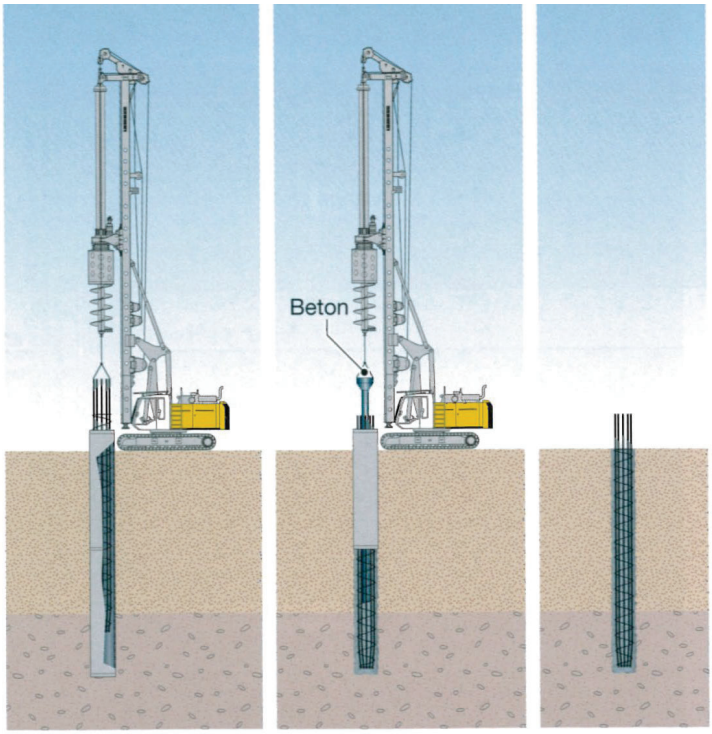
DRILLS (KELLY + AUGER / BUCKET)

1. The tube is drilled in the ground,
2. Then emptied by the auger,
3. The tube is slowly drilled, step by step. The auger must not work under the tube (possible collapse),
4. Once the bottom of the tube is reached, we do add a part that we empty, and so on, up to expected depth,



Source : Spezialtiefbau: Kompendium Verfahrenstechnik und Geräteauswahl. Set Band I und Band II, Liebherr-Werk Nenzing GmbH, Ausgabe 2009.

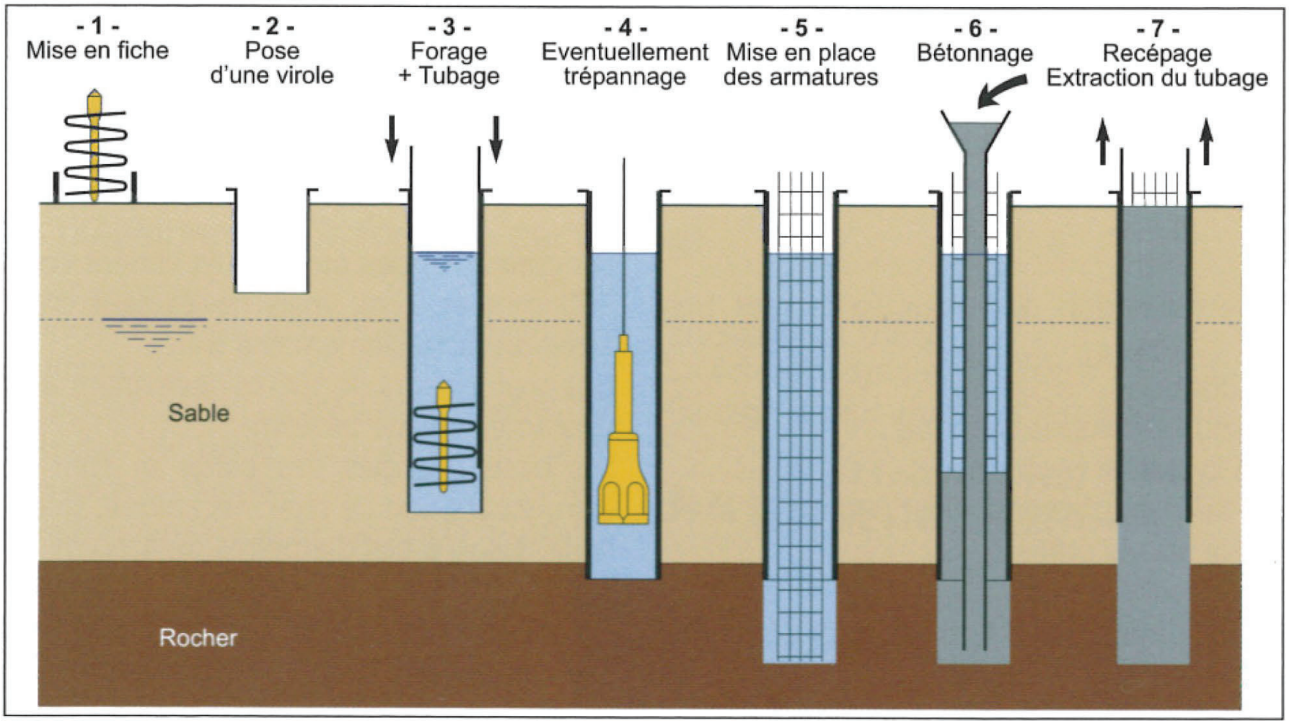
DRILLS (KELLY + AUGER / BUCKET)



5. When expected depth is reached, we are cleaning the bottom of the pile before lower the reinforcing cage,
6. We concrete the pile with a dip tube by removing the tubing, by steps,
7. Once the upper level is reached, the pile is ready.

Source : Spezialtiefbau: Kompendium Verfahrenstechnik und Geräteauswahl. Set Band I und Band II, Liebherr-Werk Nenzing GmbH, Ausgabe 2009.

DRILLS – EXECUTION PHASES



Source : Guide technique Solétanche-Bachy, http://www.soletanche-bachy.com/SBF/sbf.nsf/Guide

DRILLS (KELLY + AUGER / BENNE)

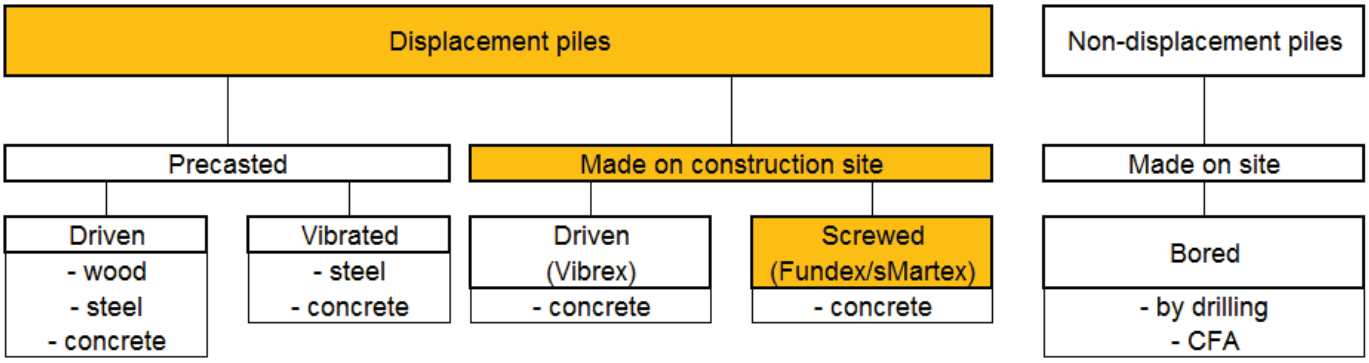
benefits

- only little noise and vibrations,
- control on extracted ground,
- barrel passage and hardpan possible = length guaranteed,
- easy energy equipment, required length always reached,
- easy adjustement of length of the pile,
- large diameter and big length possible.

limits

- poor efficiency,
- expensive,
- difficult to impossible tilt,
- delicate implementation (sewage, concreting),
- risk of damage of E-tubes during concreting
- No check of the bearing capacity in execution,
- no ground shrinkage (lower bearing capacity for same ø),
- cost of discharge of materials if grounds are polluted.

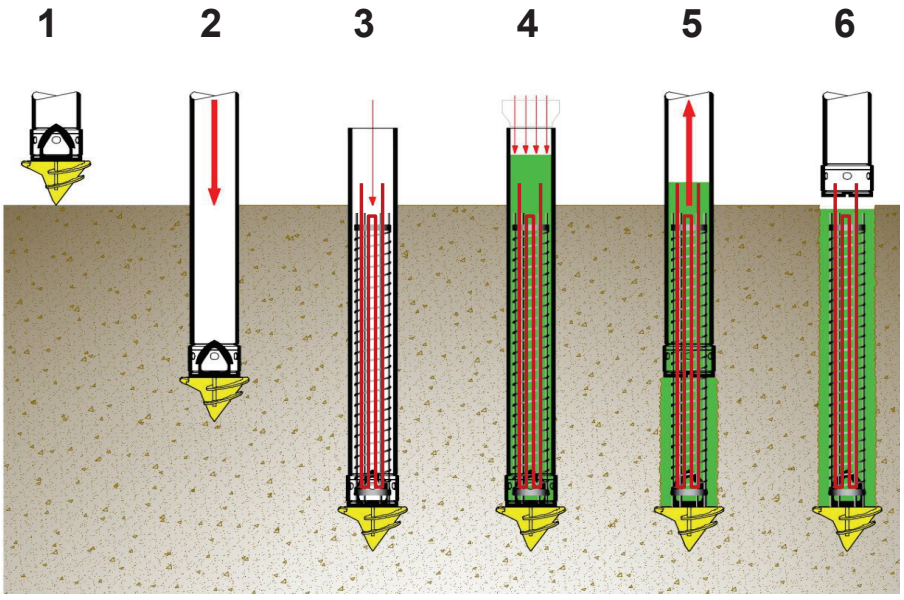
TYPES OF PILES



SCREWED PILES (SMARTEX)

Execution method

1. **The drill bit is arranged at the end of the tubing,**
2. **Tube is driven into the ground to expected depth,**
3. **The reinforcing cage is run down into the dry tubing,**
4. **Pile is concreted,**
5. **Tube is lifted (the drill bit remains at the bottom),**
6. **Pile is ready.**



Source : www.marti-gruendungstechnik.ch

SCREWED PILES (SMARTEX)

benefits

- high efficency,
- reinforced around the entire length,
- easy energy equipment,
- bearing capacity evaluated during implementation,
- ground push down, favorable for bearing capacity,
- no excavated material,
- screwed pile, less noise and few vibration.

limits

- only possible in soft to grounds or average grounds,
- piles can be stopped by a hard layer (geotechnical study),
- barrel passage impossible,
- piles can be deviated around the blocks.

KEY POINTS: CAGE LAYING OF

Piles get different lengths. Right cage must be set at the right place. It's impossible to extract the cage after laying of !

Handling of the cage is delicate on the construction site, several places to build the cages are set to reduce handling.

LIFTING...

The bottom of the cage is attached to the excavator.

LIFTING...

The top of the cage is attached to the crane of the drilling rigs.

LIFTING...

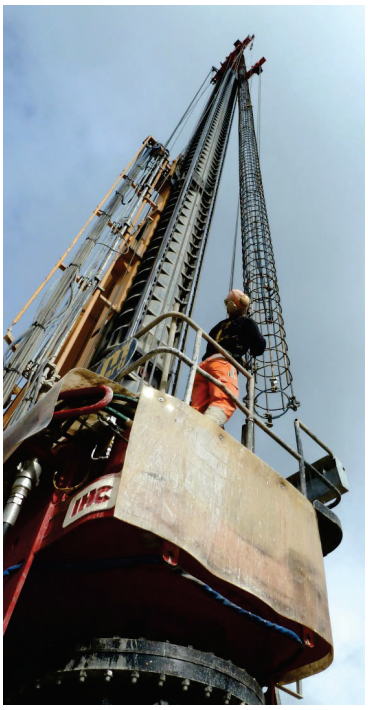
LIFTING ...

LIFTING ...

LIFTING ...

LIFTING…

The cage (ø500) is 35 m long and weigh 25 kg/m‘ so approx 900 kg



If the top of the pile is at the level of the natural ground, we can control the pressure in the energy tubes after concreting...

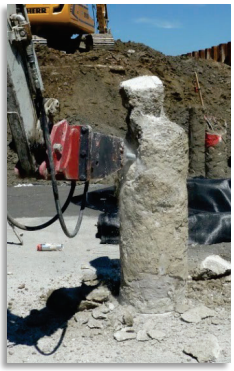
…otherwise we need to wait for the cut-off

PILES CUT-OFF

The excavator dig around the piles…

…saw…

…steal…

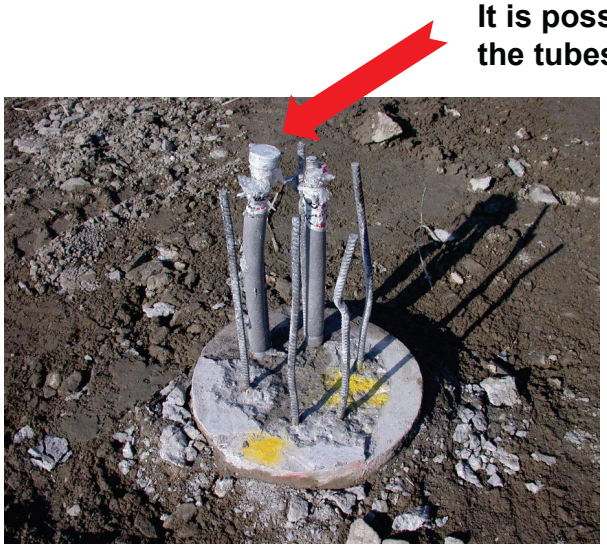


… complete carefully…

PILES CUT OFF

Protection of the tubes is crtical as this is the more delicate phase in the execution.

It is possible to control of the pressure in the tubes with a pressure gauge.



…Cut off done

The foams and the elbow pipe are protecting the tubes.

LAYING OF THE CONNECTING PIPE

After checking the pressure, the tubes are released…

… and connected to the tubes which will run under the raft slab…

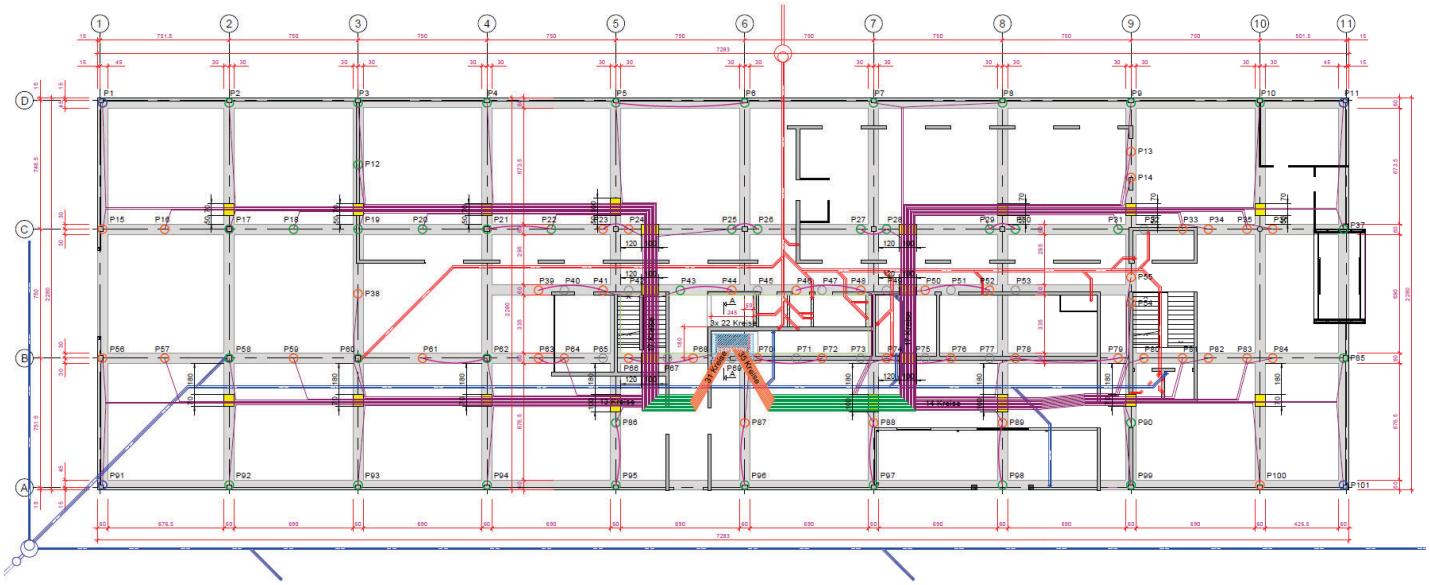
LAYING OF THE CONNECTING PIPE

… Concrete the first step of fundaments…

… and connected to the tubes under the raft slab.

LAYING OF THE CONNECTING PIPES

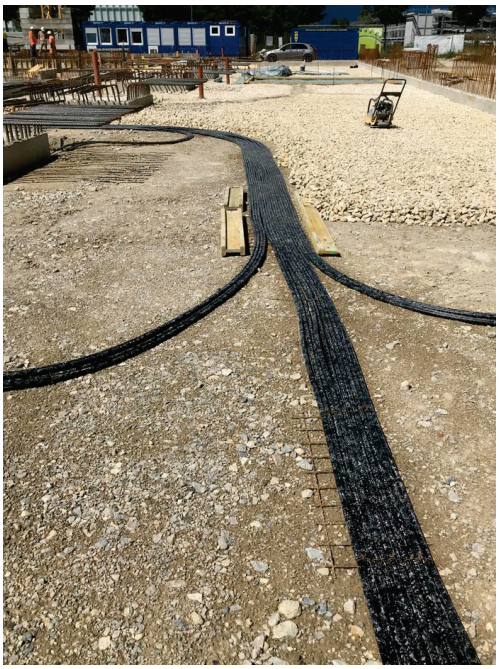
They are connecting the piles with each other to the collectors (back and forth). The tubes system is usually several kilometers long.



Source : Enercret AG / Marti Gründungstechnik AG, Yverdon, Sylvac SA, June 2018

LAYING OF THE CONNECTING PIPES

The tubes are laid together…



… and directed to the collector…

LAYING OF THE CONNECTING PIPES

Surface must be clean. Tubes are set to the ground to avoid beeing moved during the following arrangements.

LAYING OF THE CONNECTING PIPES

A lot of hand work to do with precision. Each step with a pressure control.

LAYING OF THE CONNECTING PIPES

Tubes are tested under pressure then covered with sand.
Insulating under the raft slab is recommended to avoid condensation.

Photo : Enercret AG

www.enercret.ch

A good coordination with professionnals is essential.

LAYING OF THE CONNECTING PIPES

The tubes can be installed into the thickness of the raft slab…

Photo : Enercret AG
www.enercret.ch

…between the belt structures but the coordination is more difficult!

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

LAYING OF THE CONNECTING PIPES

The tubes can be installed into the thickness of the raft slab…

Photo : Enercret AG
www.enercret.ch

…between the belt structures but the coordination is more difficult!

LAYING OF THE CONNECTING PIPES

Another disadvantage of this solution is the risk of condensation appearing on the surface of the slab.

Condensation has no technical impact but is best avoided. It's not aesthetically pleasing and it can be slippery (Winter).

This does not happen if the pipes are under the raft slab and there is insulation under the raft.

If there is no insulation under the raft slab, we recommend installing 2 cm of insulation in areas where there is a group of more than ten pipes.

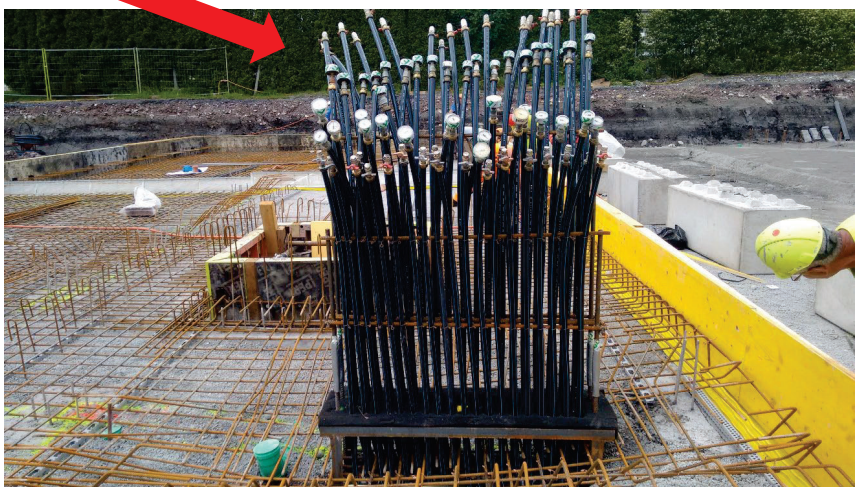
LAYING OF THE CONNECTING PIPES

All tubes should reach the manifold.
We must be able to identify each loop.

Photos : Enercret AG www.enercret.ch

LAYING OF THE CONNECTING PIPES

Each loop is equiped by a manometer and a valve that helps controling any time.



Photos : Enercret AG www.enercret.ch

injectable sealing system in case of ground water table.

INSTALLATION OF THE COLLECTORS

When the building is ready, we can install the collectors.

Manometers enable to monitor that the system is still under pression.

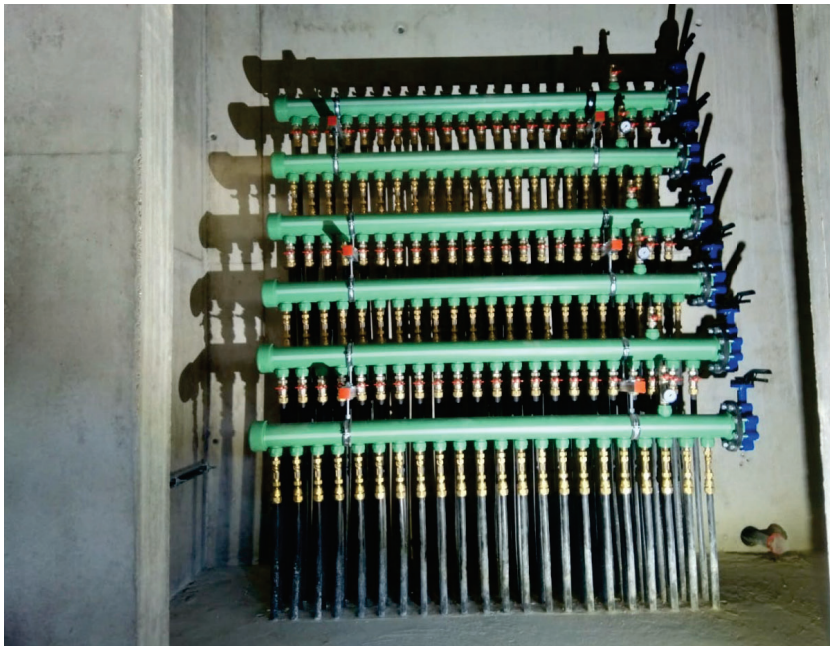
INSTALLATION OF THE COLLECTORS

When the building is done, we can install the collectors.

Photo : Enercret AG, www.enercret.ch

INSTALLATION OF THE COLLECTORS

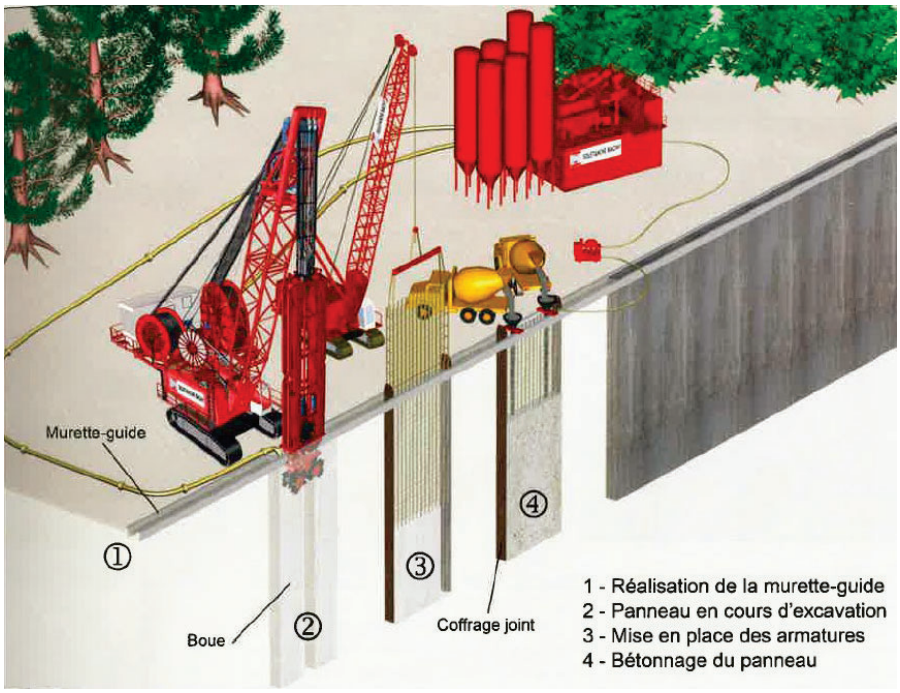
When heay lifting is done, we can install the collectors.



Photos : Enercret AG, www.enercret.ch

EQUIPMENT OF DIAPHRAGM WALLS

Embodiment is pretty similar to the ones for bored piles under mud.



Source : Guide technique Solétanche-Bachy, http://www.soletanche-bachy.com/SBF/sbf.nsf/Guide

EQUIPMENT OF DIAPHRAGM WALLS

Difficulties are identical: handling of the cage…

Photo : Sif-Groutbor SA, www.sif-groutbor.ch

EQUIPMENT OF DIAPHRAGM WALLS

Difficulties are identical: handling of the cage…

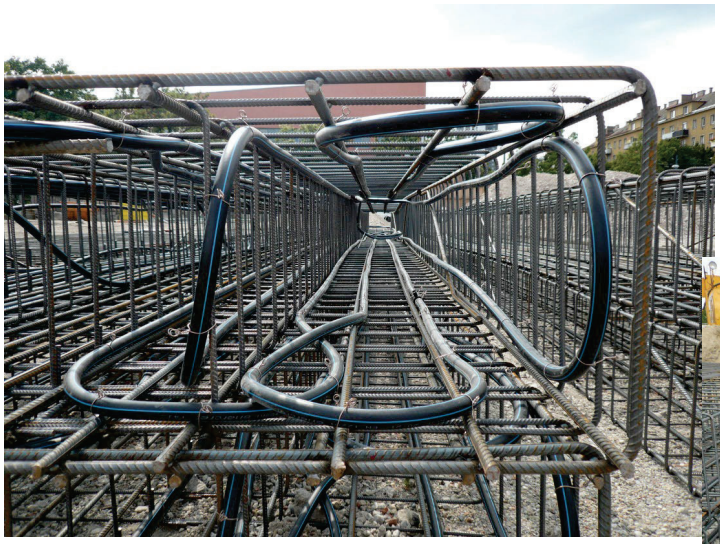
Photo : Sif-Groutbor SA, www.sif-groutbor.ch

Photo : Strabag AG, www.strabag.com et Enercret AG, www.enercret.ch

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

EQUIPMENT OF DIAPHRAGM WALLS

… and protection of the tubes for plating of the wall.



Photos : Strabag AG, www.strabag.com et Enercret AG, www.enercret.ch

ONE DIFFICULTY: TUBE DRILLED / DAMAGED / PINCHED

1. **Inform and communicate to all professionals: pick out a leak and repair a tube at the right time is easy, fast and cheap.**

   → Encourage anyone to report any observed defaults!

2. **Maintain tubes under pressure. A drilled tube air-filled whistles, water-filled, it spurts.**

3. **Take into account in the planning a percentage of defective piles (1 to 2%).**

4. **Set manometers and do controls during all phases…**

CONTROLS OF PRESSURE

1. **After assembly of the tubes in the reinforcing steel cage,**
2. **After concreting of the pile (if possible),**
3. **After the cut off of the head of the pile,**
4. **After installation of the horizontal tubes,**
5. **After coating of sand (tubes under the raft slab) / before concreting of the raft slab (tubes in the concrete of the raft slab),**
6. **Before the installation of the collectors,**

→ When realizing controls during installation, and with a bit of luck, we can get 100% fonctionnal piles before installation of the collectors.

CONCLUSION

Piles equipment or panels of diaphragm walls in energy geostructures :

1. **Need a good coordination of the professionnals working on the project,**
2. **Execution of work requests :**
   - Experience for the equipment and handling of the cages,
   - A craftsmanship of the cut-off of the piles,
   - Attention of all professionnals to protect and maintain tubes,
   - Good patnership between professionnals.

With experience, energy piles can be made without lengthening construction times.

STATE OF THE ART

> 15 years' experience

> 60 projects in Switzerland and Liechtenstein

> 10'500 E-piles installed, i.e. 255 km

- Largest project : Kriens Mattenhof (2016) 1'190 energy piles
- Smallest project Oberägeri MFH Brand (2019) 30 energy piles

At present, we have acquired the know-how to construct the E-piles.

The system is suitable for installations of all sizes.

Technology is ready.

COST ELEMENTS

Of course, every project is different, but the cost of converting piles into energy piles is around :

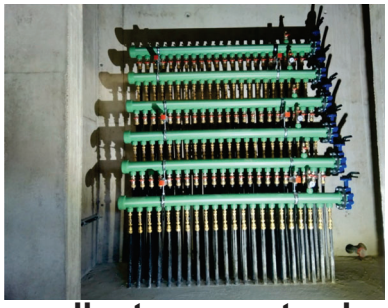
Between CHF 800 and CHF 900

to equip a 30 m pile ready to be connected →

It costs between CHF 1'900 and 2'100 per pile

to install the entire system, including

the collectors in the plant room →



An installation with 100 piles 30 m long, including collectors, costs about CHF 210'000 and produces about 270'000 kWh per year.

COST ELEMENTS

Experience shows that when piles are planned for the project, transforming them into energy piles is less costly than drilling vertical geothermal boreholes.

If geothermal drilling is planned under the building, there is an advantage in terms of construction planning. With geothermal piles, construction can start immediately, whereas geothermal drilling takes several weeks.

DEVELOPMENT PROSPECTS

At present, the investment cost of non-renewable heating remains significantly lower than that of renewable heating.

It takes 5 to 10 years to make an E-Pile installation profitable, depending on the cost of energy (heating oil, gas, etc.) and the use made of the installation.

→ Anyone looking at the short term is still opting for a non-renewable solution

→ Some foundation companies do not offer this type of installation because they consider the demand too low to justify acquiring the know-how.

→ The system is not yet sufficiently well known to engineering offices specialising in heating.

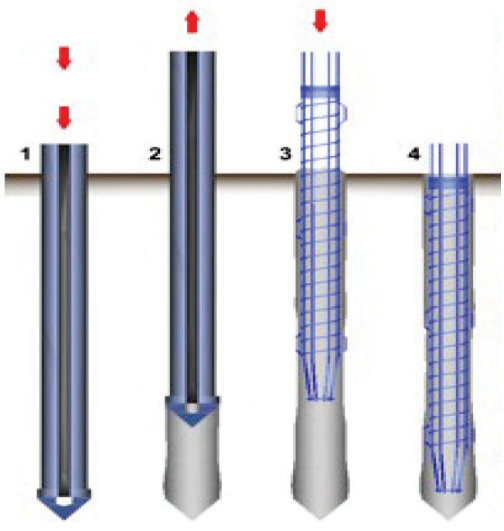
→ There is potential for optimising the operation of large installations, but operating data is still lacking.

DEVELOPMENT PROSPECTS

Today, energy piles are mainly used for long piles (25 to 40m).

However, short piles (8 to 15m) are frequently used. For these lengths, energy piles are more expensive than vertical geothermal drilling.

A specific system is currently being tested and will be launched on the market next year.



LATEST INSTALLATIONS

(ENERGY EQUIPEMENT OF PILES BY ENERCRET AG, 9470 BUCHS)

Projet	Lieu	Nombre de pieux	Nombre énergétiques	Longueur	Exécution
Stucasa AG	3627 Heimberg	90	85	20-30	Juin 2024
Vitrocsa SA	1400 Yverdon	128	65	22-36	Mai 2024
GWG Riesenmattstrasse	3294 Büren a. A.	62	62	22-25	Mai 2024
MFH Escherfeldstrasse 5	8880 Walenstadt	174	82	11-14	Avril 2024
Casa Molino	6374 Buochs	52	33	27-37	Février 2024
WÜB Schällenmatt Sud	6010 Kriens	373	290	28-33	Novembre-Décembre 2023
Haus Bühler	9493 Mauren	105	80	23	Novembre 2023
Grosmadpark	9492 Eschen	153	94	22	Octobre 2023
WÜB Allmendstrasse 20	6048 Horw	143	88	30-45	Octobre 2023
Büron BG EROWA AG	6233 Büron	282	180	32 -35	Mars-avril 2022
Poste LZV 2022	5612 Villmergen	1077	500	35-40	Juillet-septembre 2022
CC Aligro	7323 Wangs	456	150	25-30	Mars-avril 2022
Bürohaus im Bretscha	9494 Schaan	111	70	17-24	Février 2022
WÜB Mosaik Eymatt	3930 Viège	448	386	15-18	Novembre-décembre 2022

Marti Techniques de fondation SA
www.marti-gruendungstechnik.ch

QUESTIONS...

... THANK YOU FOR YOUR ATTENTION