Centro de Inovação em Construção Sustentável

Geotermia integrada nas estacas da fundação

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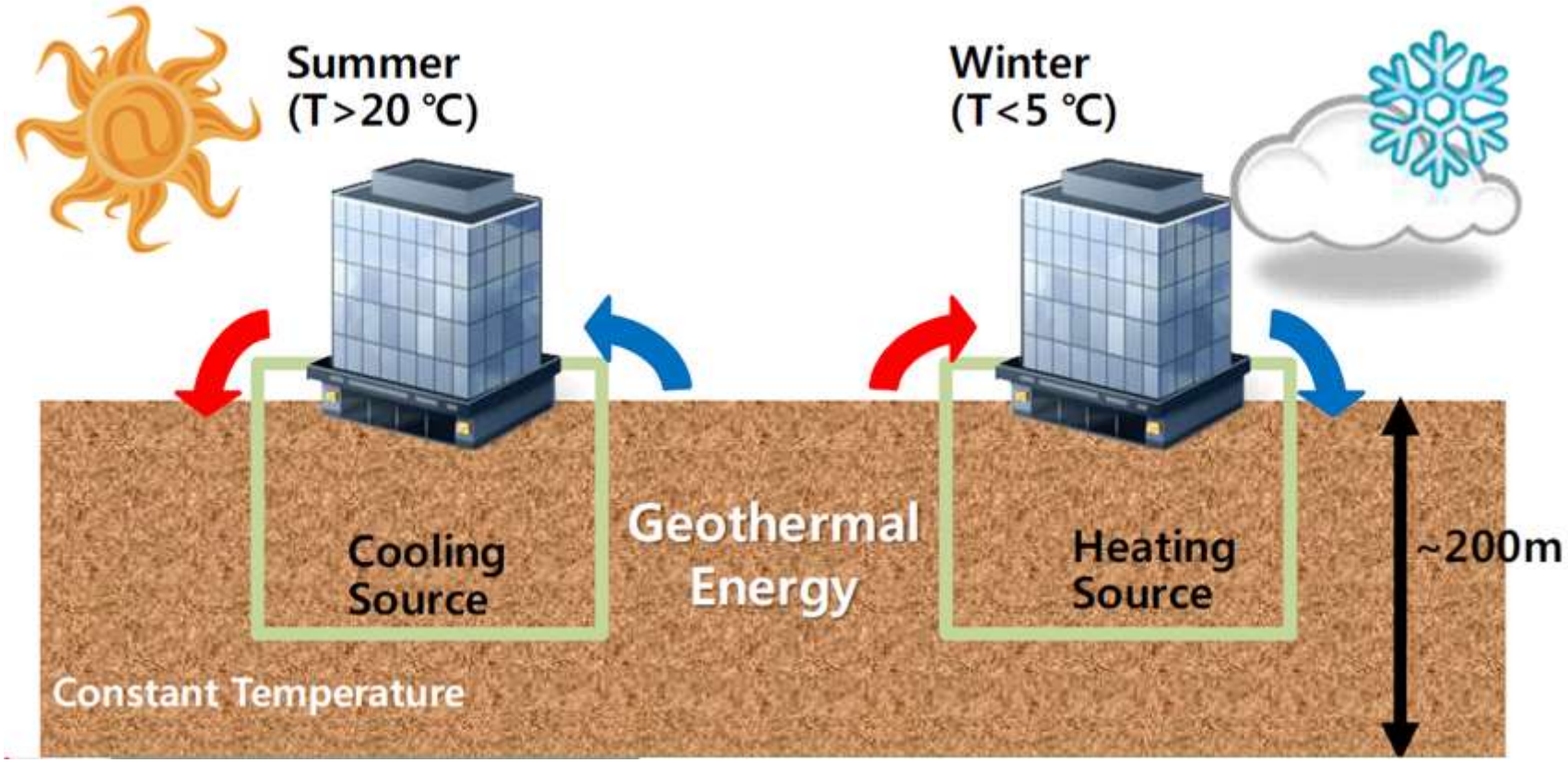
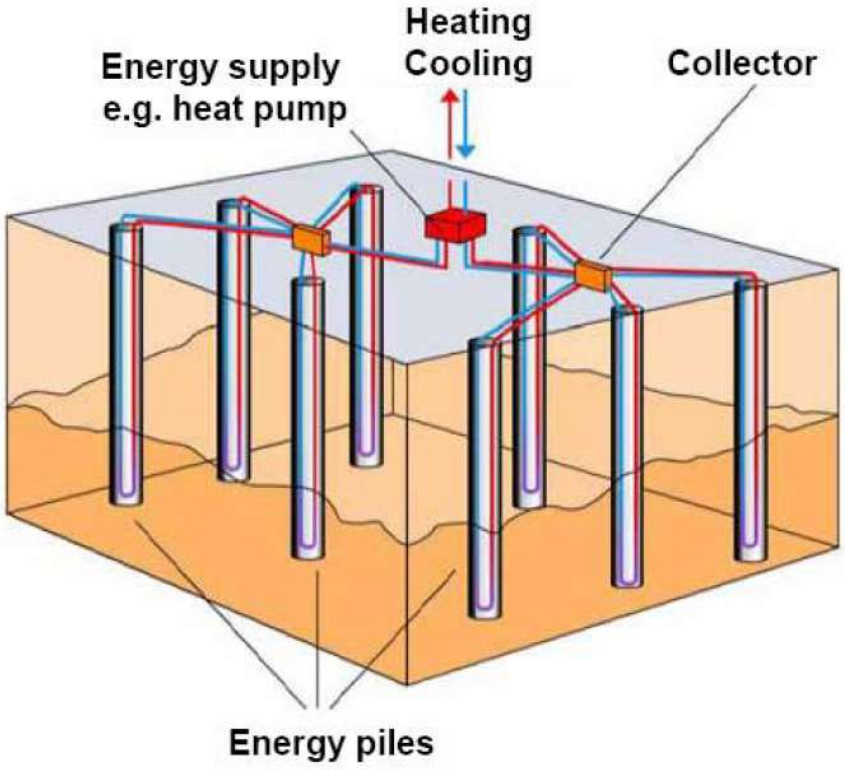
Structure of presentation

- ✓ Energy piles / Tropical and sub-tropical climate (air cooling need)
- ✓ Energy piles in Brazil
- ✓ Evaluation of soil thermal characteristics for CICS project
- ✓ Design for CICS – Soil/Climate conditions and Foundations
- ✓ Monitoring programme
- ✓ Installation of the heat exchanger pipes in the pile foundation

Shallow geothermal energy

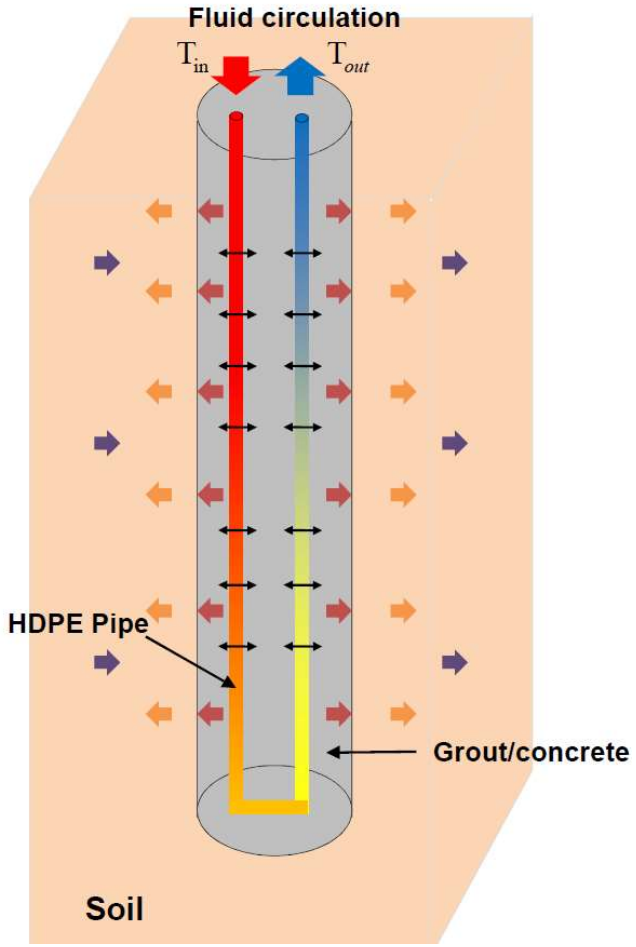


Energy pile systems



Primary circuit (piles)

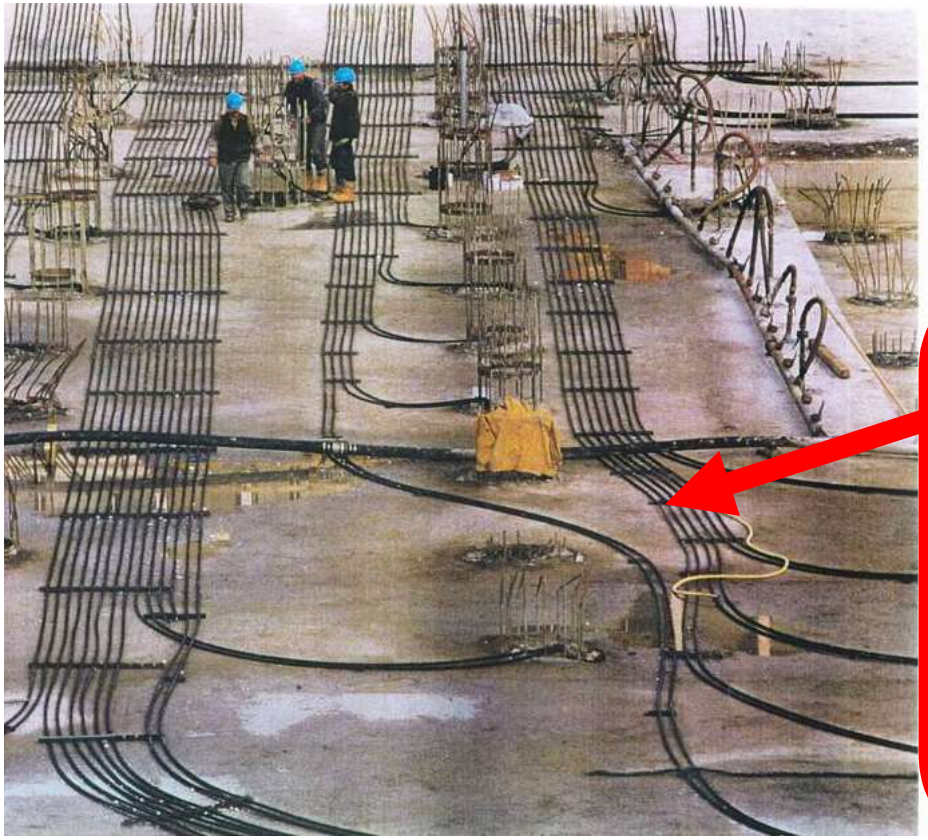
Energy pile / Heat transfer mechanism

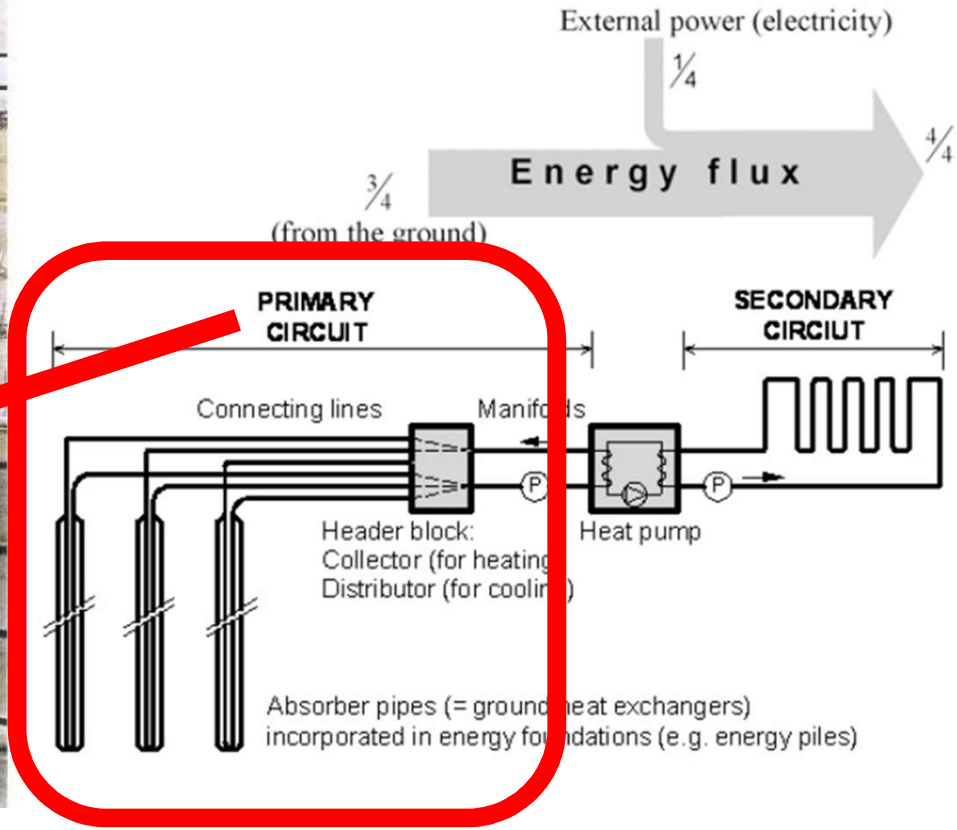


pipes attached to the reinforcement cage of the pile

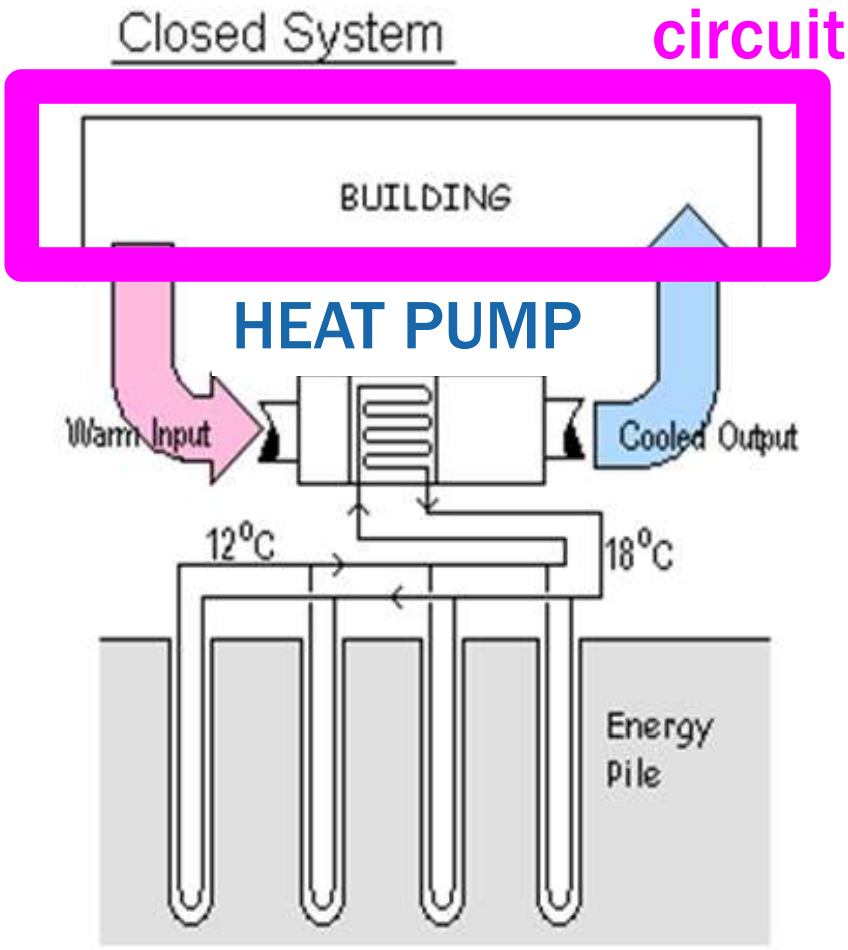
One or more loops

Primary circuit



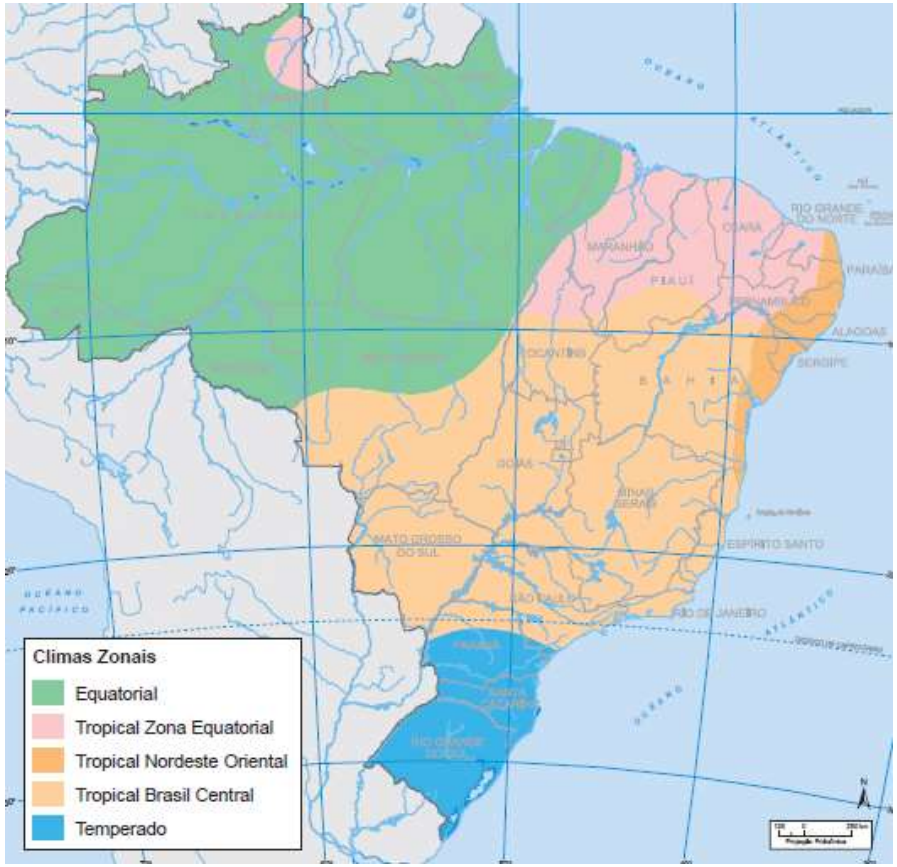


Secondary circuit



Energy piles –Brazil

Energy piles / Tropical and sub-tropical climate (air cooling need)



In 2015, 48% of the total national electricity consumption refers to Brazilian buildings (222 TWh).

In 2005, air conditioning equivalent to 20% of residential consumption and 47% of commercial consumption.

Brazil is the 5th largest consumer of air conditioners in the world.

System to reduce electricity consumption

Energy piles in Brazil

- 2014 - Sao Carlos (USP)

Drilling pile (12 m)

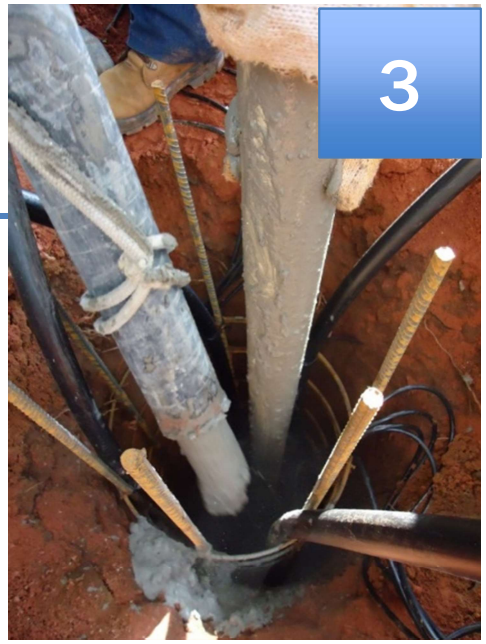
- 2016 - Sao Paulo (USP)

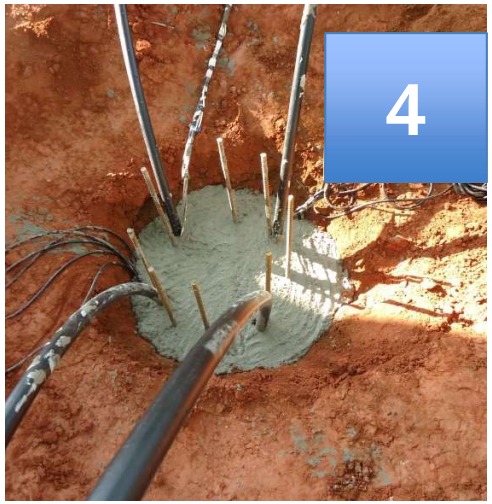
Micropile (15 m)

Energy piles in São Carlos

High-density polyethylene (HDPE) tubes

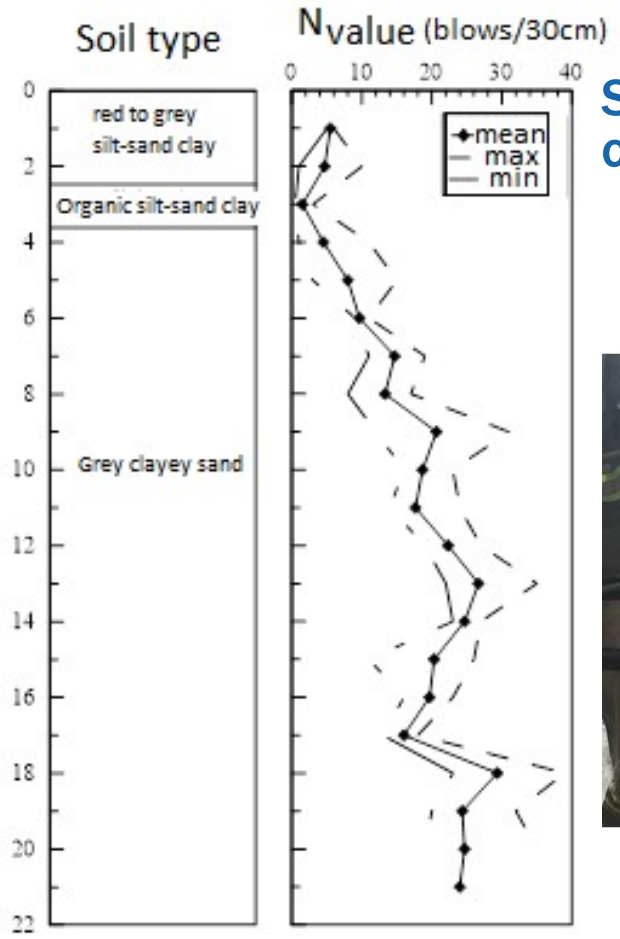
(32-mm outside diameter and 3 mm wall thickness)





CICS

First building using energy pile systems in Brazil



Soil characteristics

"MICROPILE"

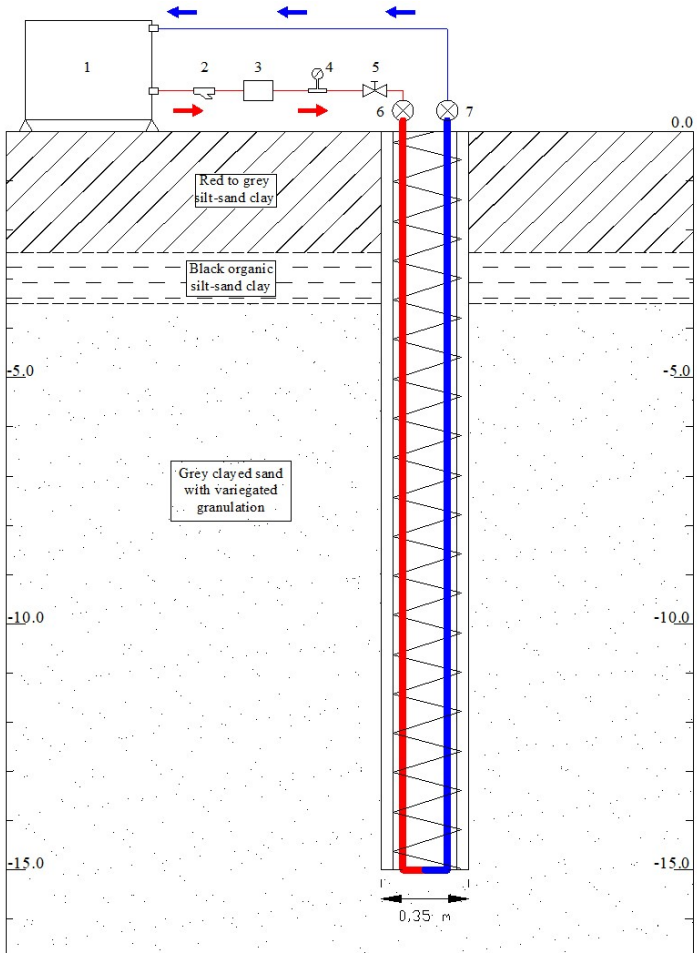
Single "U" loop

Pile cage

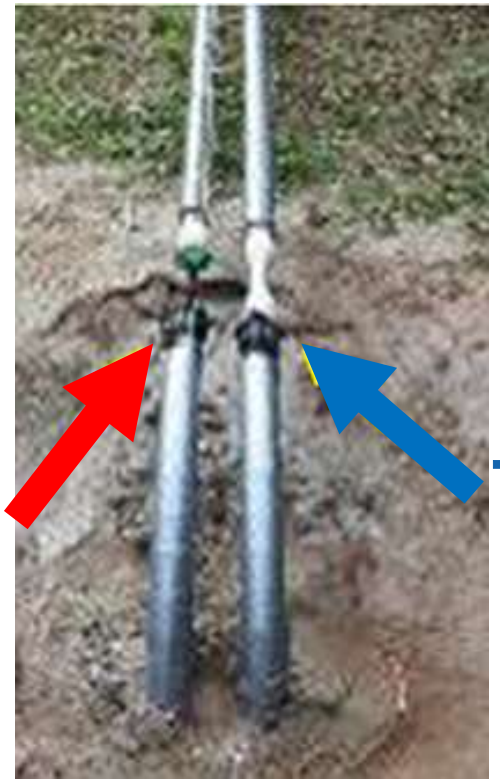
Energy pile in São Paulo (Poli - CICS)

Soil thermal characteristics for CICS Project

- Thermal response test (soil thermal conductivity)



1 - Heater reservoir
2 - Filter cleaning
3 - Circulation Pump
4 - Flow meter
5 - Flux control valve
6, 7 - Thermistors (T_{in} and T_{out})

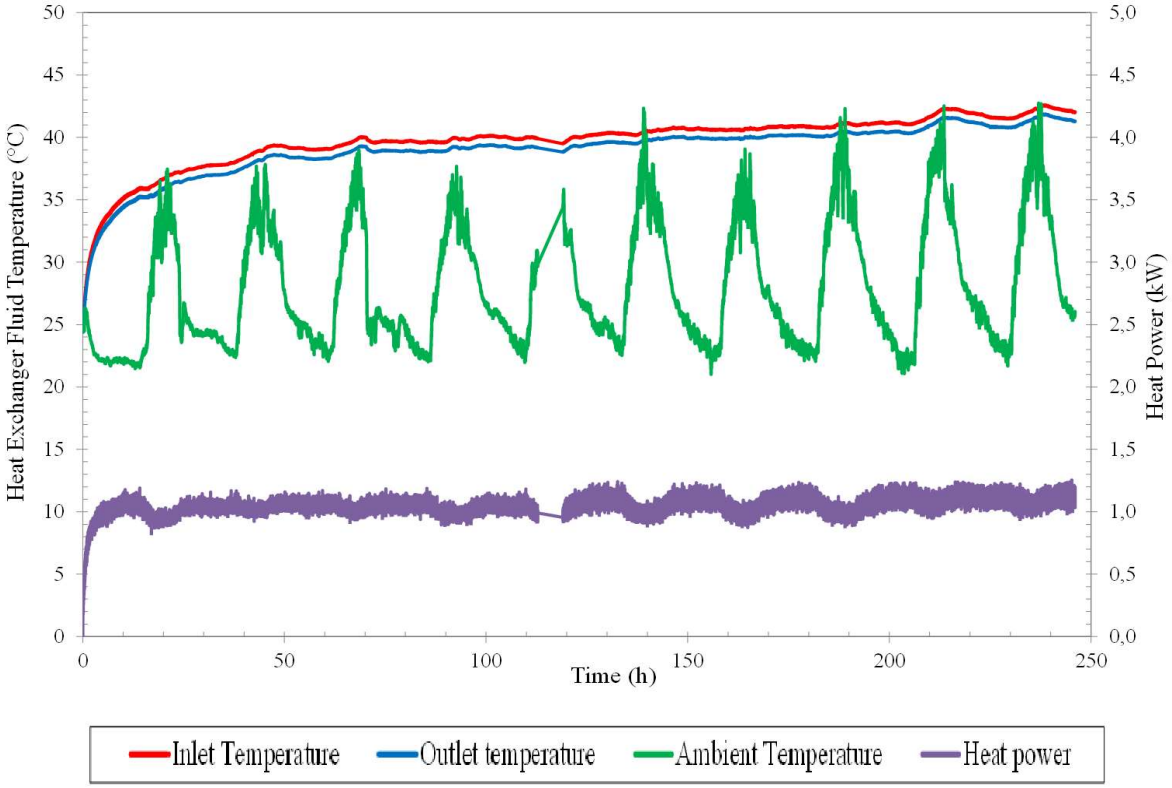


T"in"

T"out"

Soil thermal characteristics for CICS Project

- Thermal response test (soil thermal conductivity)



thermal conductivity

saturated clayed

sand soil

= 2.82 W/m°C

CICS – soil, climate conditions, and foundations

Mean soil temperature 24-25°

Saturated sand

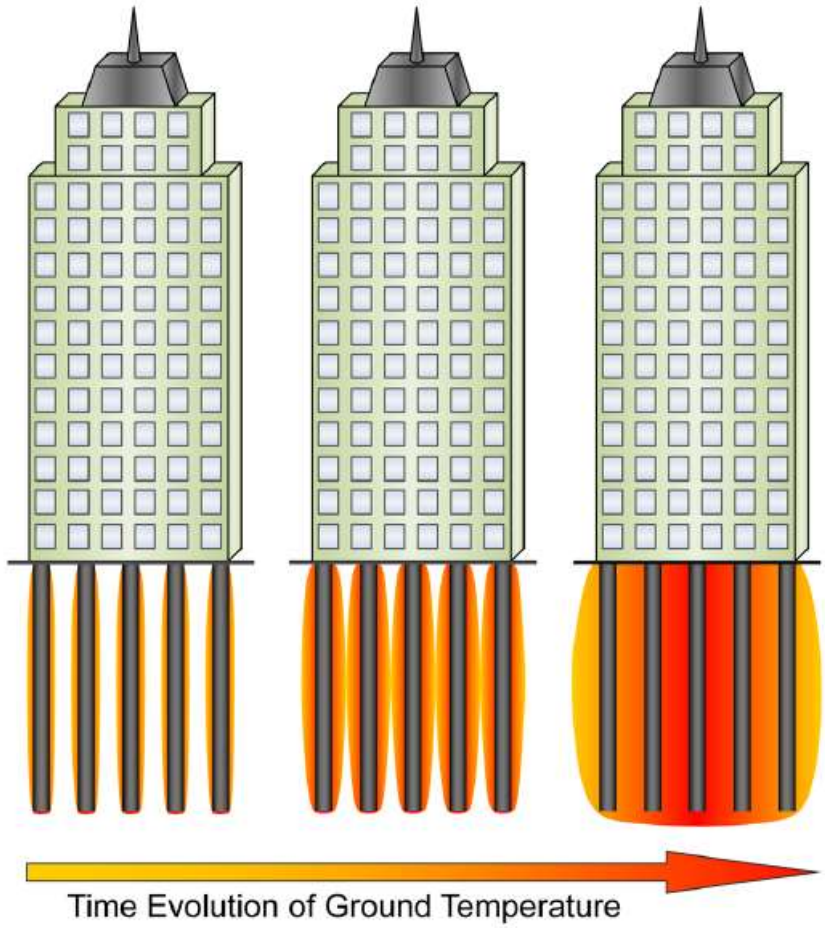
High permeability

groundwater flow rate

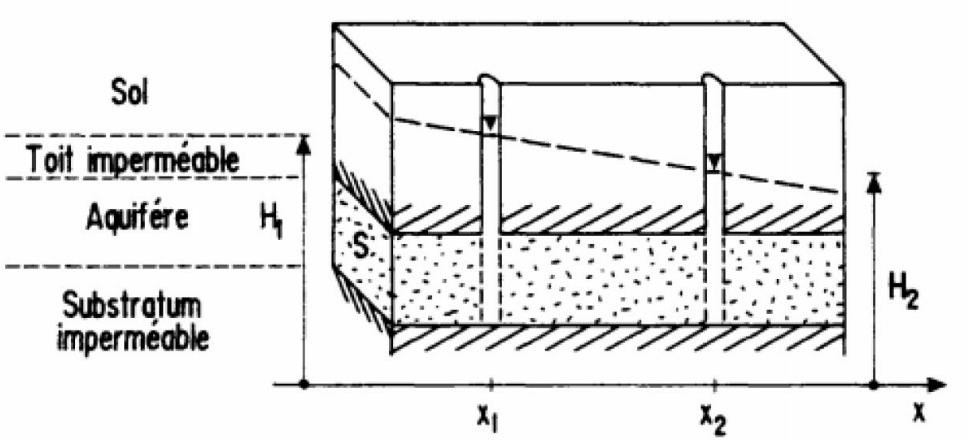
Favorable condition

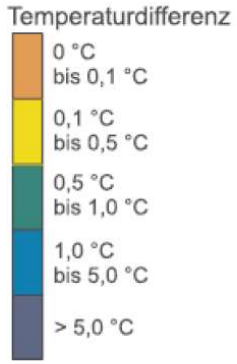
beneficial to the recovery
of soil temperature

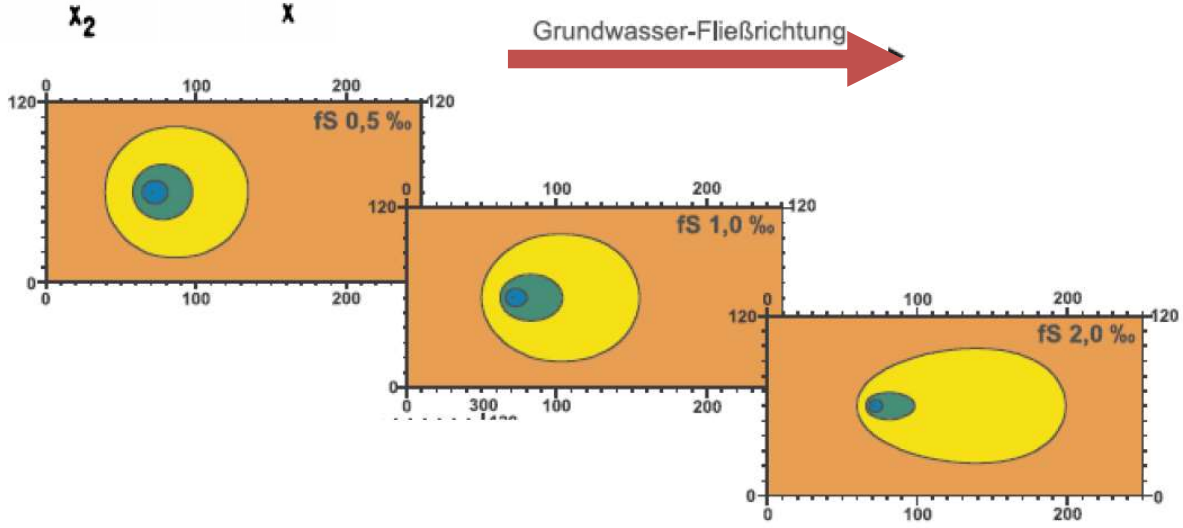
"systems used only air cooling"



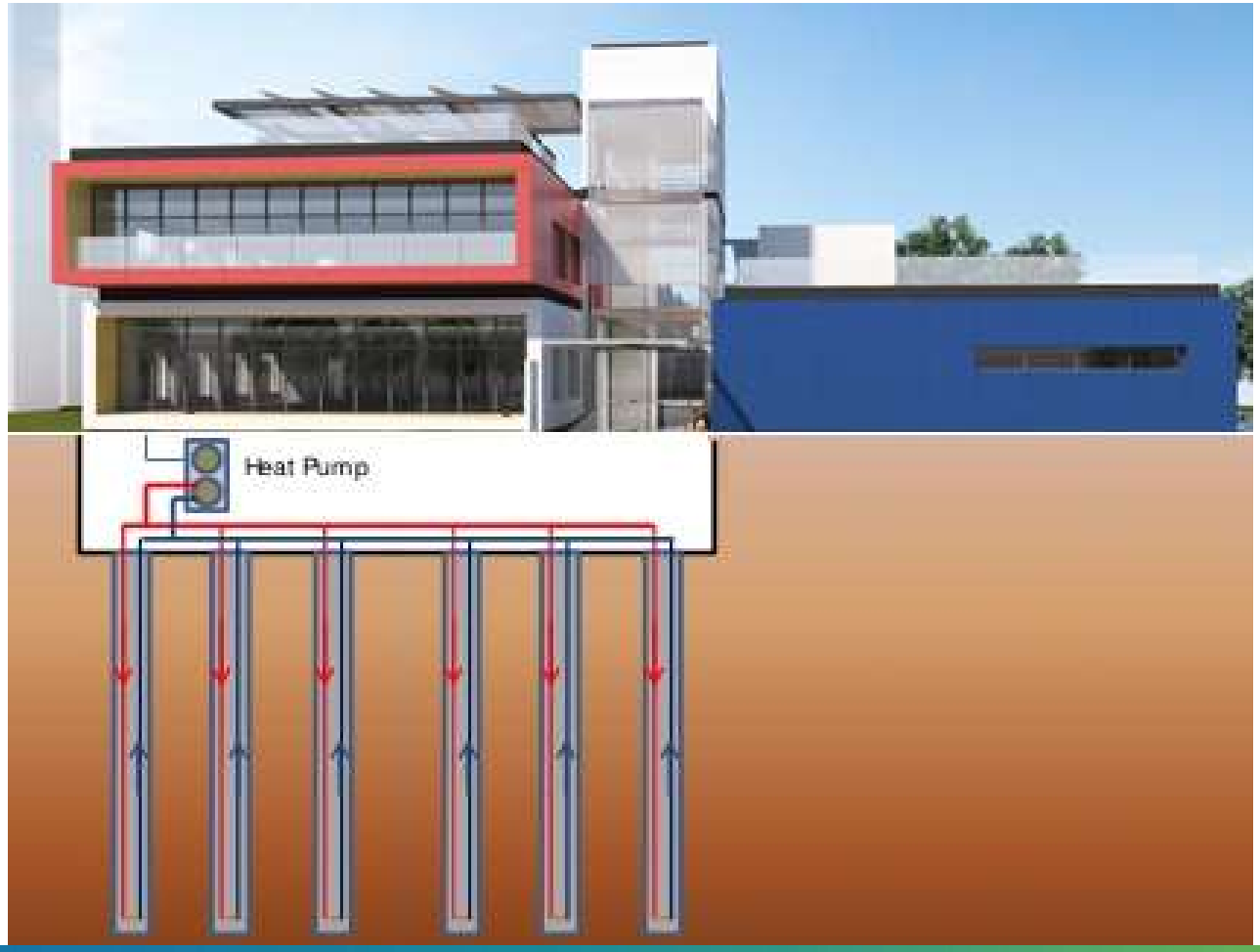
CICS – groundwater flow rate (direction)



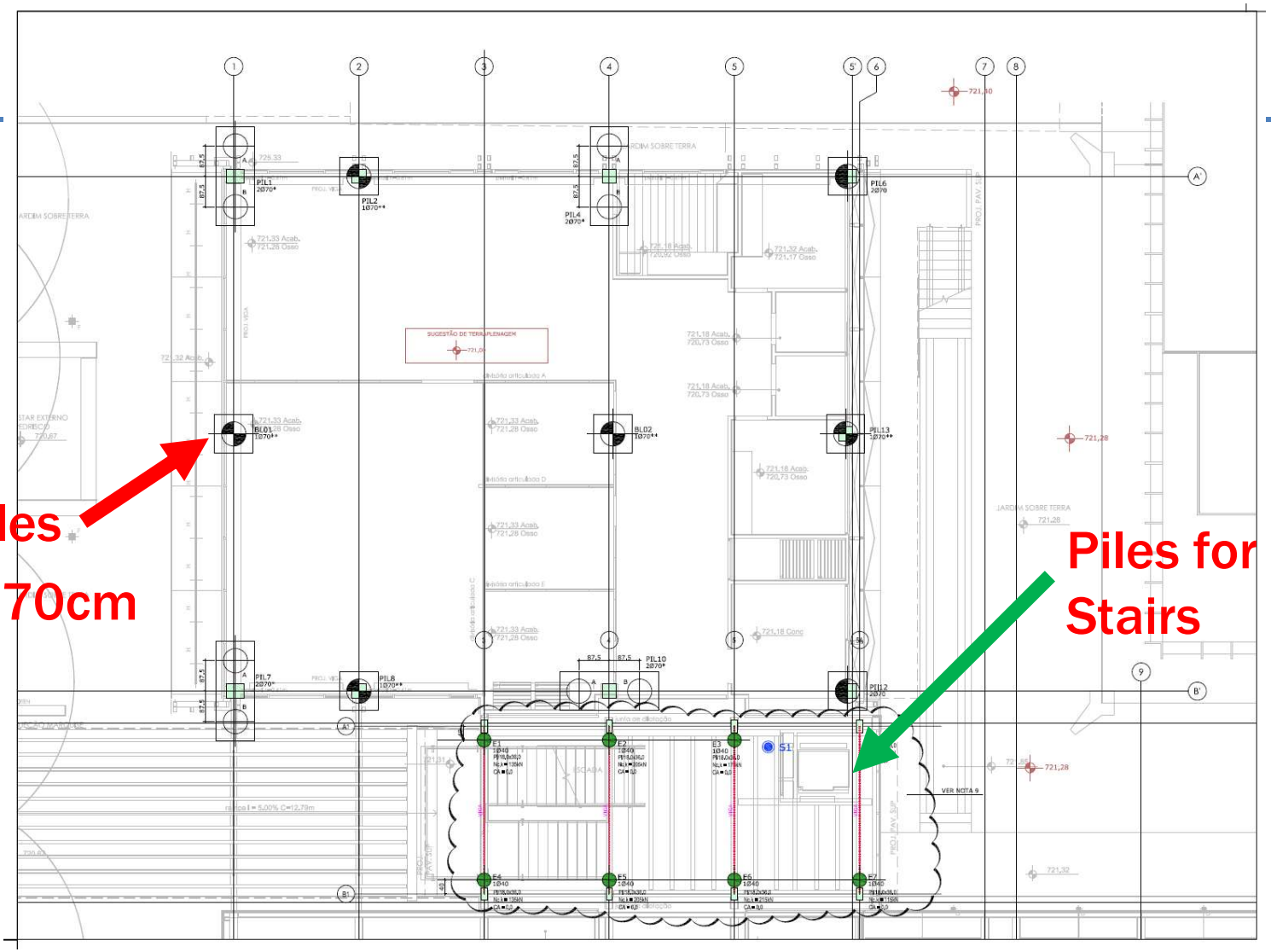




CICS – Pile foundations



CICS – Pile foundations



CICS – Monitoring programme

- Thermal Performance of the Energy Pile System (heat exchange rate - W/m)

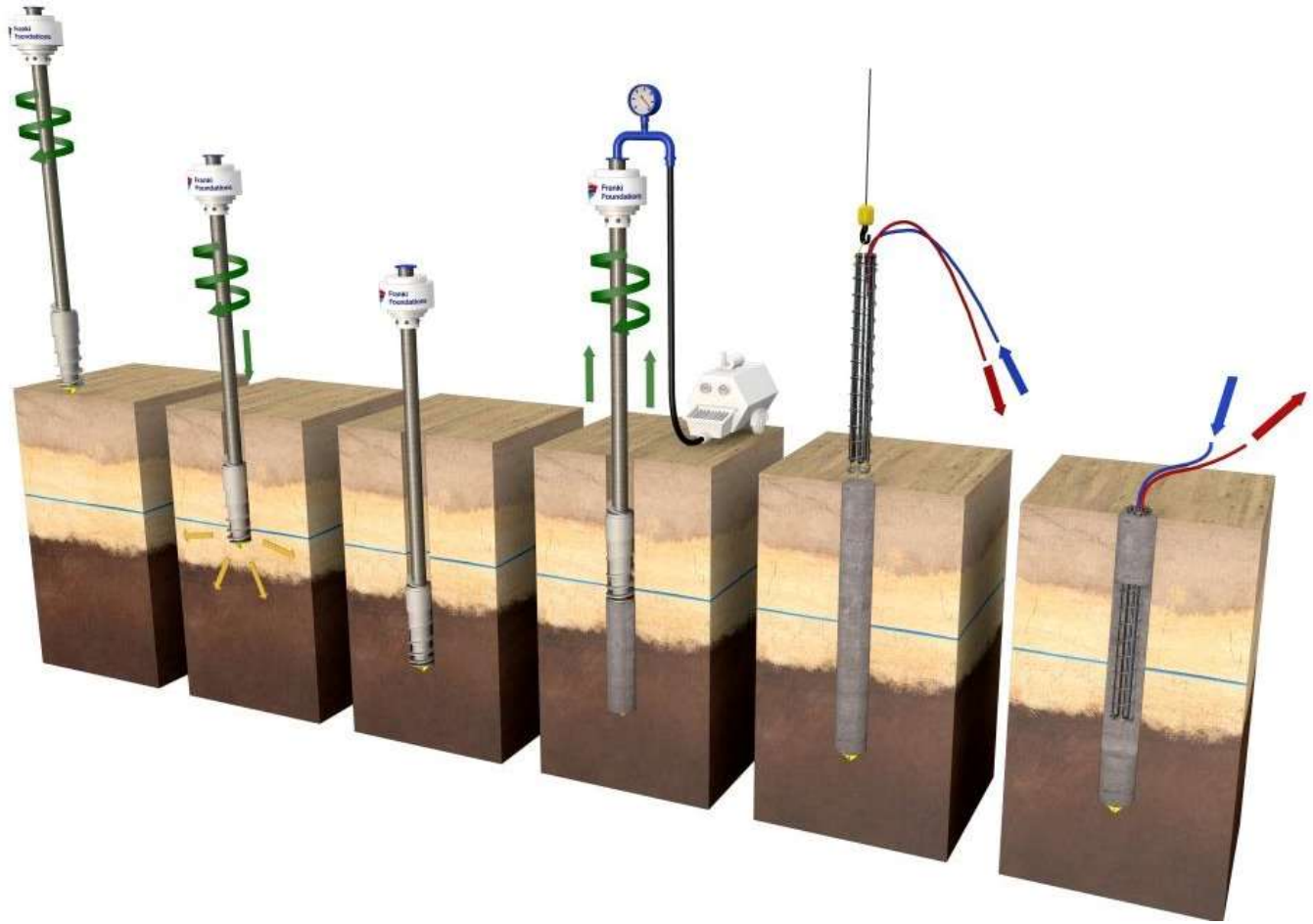
- Performance x time (increase of ground temperature) thermistor sensors in the piles and soil

- Effect on the foundation behaviour/settlements
  - piles instrumentation (effect of cyclic thermal loads)
  - monitoring program periodically measure the building movements (after pile heating periods)

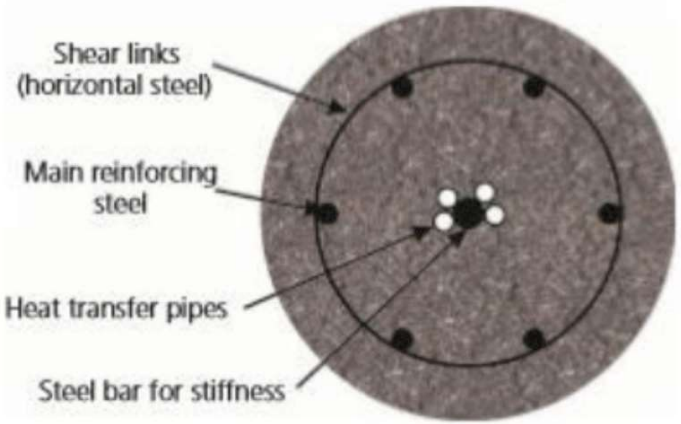
CONTINUOUS FLIGHT AUGER (CFA)

- ✓ Most suitable solution for the CICS Foundation designers – Consultrix
- ✓ Adapted the geothermal system in the chosen foundation solution

CFA with geothermal tubes



CFA with geothermal tubes



Pipes and steel bar
plunged into centre of pile
after concrete is poured

CFA with geothermal tubes (cage installation)

- Bottom of the cage

- Eng. Alberto Porto (Consultrix)