GRUND- PFAHL- UND SONDERBAU

HLV® - Pile

High level displacement pile

Consulting | Design | Execution

The HLV® - Pile

High level displacement pile

HLV®- piles *are an ideal system to transfer loads for any type of foundations, e.g. for building structures, halls, bridges, sewage plants, dams, pipelines, etc.*

Dornbirn/Austria

Ideally a universally applicable, prefabricated driven pile system should fulfill the following requirements:

- The material should be resistant and not be damaged by driving with extremely high impact.
- Once driven into the soil, the material should secure a safe foundation without problems for many decades.
- It should be possible to produce piles of almost any length on site during construction. The final pile length should be determined exclusively on the basis of local soil conditions determined by the penetration resistance measured. This allows the foundation to be flexible and economically adaptable to prevailing soil conditions.

Gmunden/Austria

Altaussee/Austria

- On site, the individual pile sections should be quickly, simply and safely connectable to form a secure and force-bearing connection.
- Pile construction should require only light and few pieces of equipment, allowing small constructions even in narrow spaces.
- The frequency and power of impact of the pile driver should be adjusted so as to cause only minimal vibrations.
- The individual pile sections should be rather short to allow easy transport and construction of piles under limited working height.

Our HLV® - piles completely fulfill all these requirements. Since 1985, more than 2.0 million meters (more than 6.5 million feet) of HLV® - piles have been constructed and have proven reliable. Currently, about 200 000 m (more than 550 000 feet) of piles are installed every year.

Bruck a. d. Leitha/Austria

Driving HLV® - Piles

Process of driving

After some preliminary excavation, the initial section of the pile, fitted with a driving shoe, is positioned in the hole and driven in. The subsequent section is taken up and driven into the conical collar of the previously driven section, thus producing a stable, force-bearing connection. This driving process is repeated until the desired final depth is reached as determined on the basis of penetration resistance. The pile is then cut at the desired height according to plan design using a cutting wheel. This cut-off is fitted with a driving shoe and used as the initial section of the subsequent pile. This avoids waste. Depending on the load to be transferred, the pile head is equipped with a pressure load distribution plate and/or additional tensile reinforcements.

As the sections to be driven have only little mass, piles may be constructed using light, easy to move hydraulic excavators equipped with hydraulic blow hammers. Therefore, piled foundations may also be constructed in narrow and difficult locations. Driving the piles into the soil causes only little vibration even in close vicinity of existing buildings. The pile axis may be as close as 40 cm to the adjacent building or structure. As the piles require only little equipment, even inclined piles may be constructed at almost any angle and in almost any direction.

St. Veit a. d. Glan/Austria

Krems/Austria

Technical data

Internal load-bearing capacity – ductile cast iron

Cast iron pipes		working load (according to ONR 22567 and ETA 07/169)
Diameter	Wall thickness	
118 mm	7.5 mm	678 kN
118 mm	9.0 mm	764 kN
170 mm	9.0 mm	1,253 kN
170 mm	10.6 mm	1,391 kN

Internal load-bearing capacity – steel ST52

Steel piles		working load
Diameter	Wall thickness	
114.3 mm	6.3 mm	538 kN
152.4 mm	8.0 mm	956 kN
177.8 mm	10.0 mm	1,403 kN

External load-bearing capacity of HLV® - piles in soil

1) Piles without grouting
Piles are driven without grouting when they will be embedded in a sufficiently load-bearing layer of soil or reach rock. This allows the usage of the maximum internal bearing capacity.

2) Shaft grouting with concrete mortar
Particularly in loose soils, shaft grouting is necessary to increase external load-bearing capacity. Concrete mortar is grouted through the pile tube during driving, this mortar filling the circumferential space created by the driving shoe which has a larger diameter. This provides higher soil density and closer connection to the soil. Particularly in sandy and gravelly soils, this system reaches allowed shaft friction values of up to 200 kN/m2.

shaft grouting

External load-bearing capacity in non-coherent soil

Empirical values for load-bearing parameters:

Soil compactness	Blow number SRS 15	Driving time (sec/m)	Shaft friction value
Very loose	0 - 2	Pressed	0
Loose	3 - 5	Approx. 5 - 10	40 kN/m²
Medium dense	6 - 15	Approx. 10 - 20	80 kN/m²
Dense	16 - 30	Approx. 20 - 30	120 kN/m²
Very dense	> 30	> 30	150 kN/m²

External load-bearing capacity in coherent soil

Empirical values for load-bearing parameters:

Soil consistency	Blow number SRS 15	Driving time (sec/m)	Shaft friction value
Slurry	0 - 1	Pressed	0
Soft	1 - 2	Pressed	0
Soft - stiff	3 - 4	Approx. 5 - 10	20 kN/m²
Stiff	5 - 7	Approx. 10 - 15	40 kN/m²
Medium hard	8 - 15	Approx. 15 - 30	70 kN/m²
Hard	>15	> 30	100 kN/m²

Immissions

Noise levels during driving

Example: BVH Druckzentrum Strohal construction site	Values in dB(A)		
	L_1*	L_{50}*	L_{95}*
Basic noise level of construction site	76.0	71.1	68.8
Nose level during driving	79.0	74.1	69.7

$L_{1, 50, 95}$* = Level reached or exceeded in 1, 50, or 95% of the time of measurement

Noise levels did not rise more than 3 dB(A)

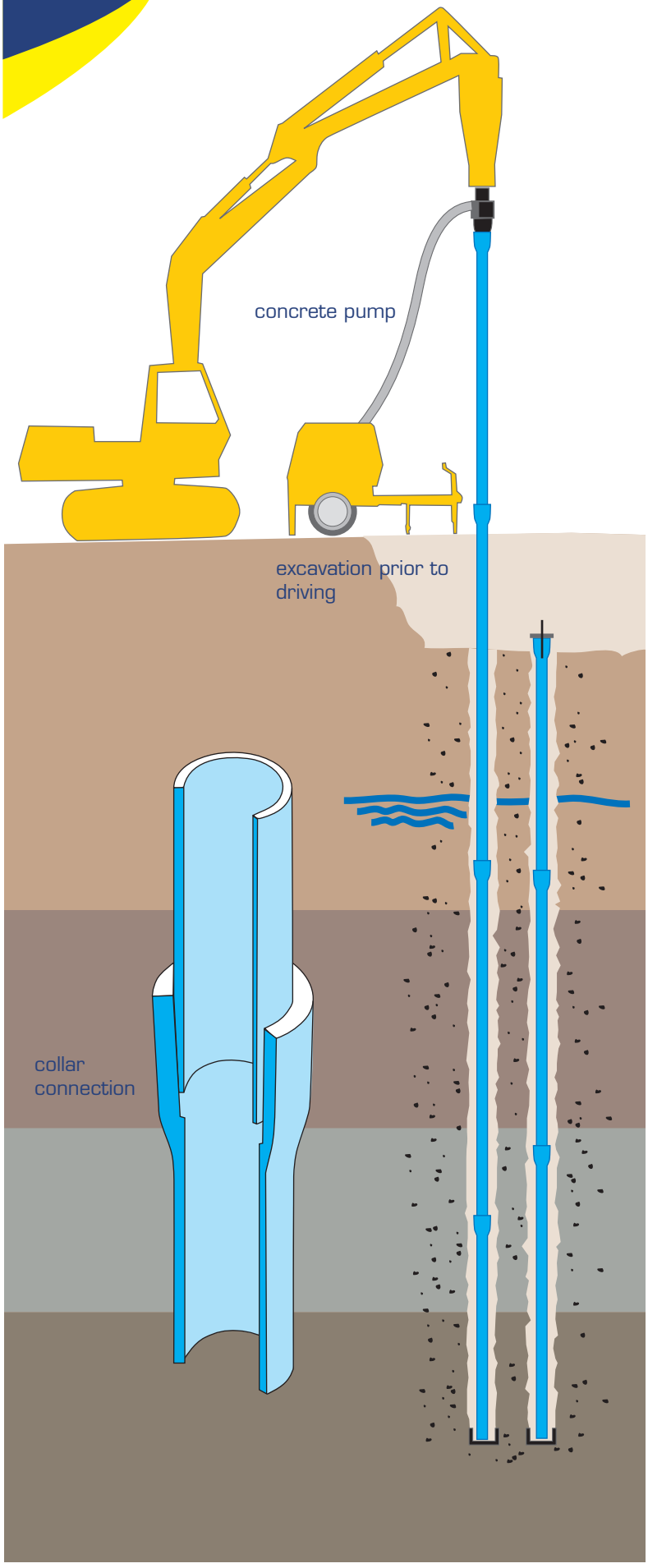
The driver noise level is in the same range as the basic noise level. If the blow hammer is about 50 m away from the measuring device, it is about as loud as a car driving close by.

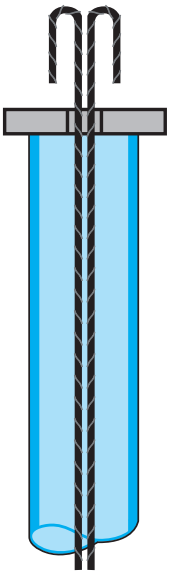
Vibrations during driving

Druckzentrum Strohal: Pile construction using 2 drivers
Maximum: 0.22 - 0.77 mm/s
Average: 0.04 - 0.13 mm/s

Admissible driving velocity according to Austrian standard ÖNORM S 9020		
I	Industrial buildings	30.0 mm/s
II	Residential buildings	20.0 mm/s
III	Buildings having less frame strength than I and II above	10.0 mm/s
IV	Historical monuments and buildings which may collapse	5.0 mm/s

Components
HLV® - Pile





tensile reinforcement according to static requirements

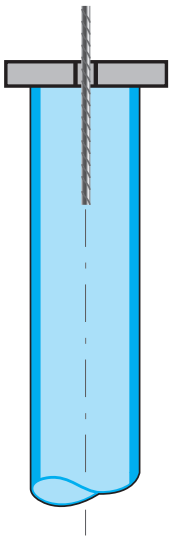
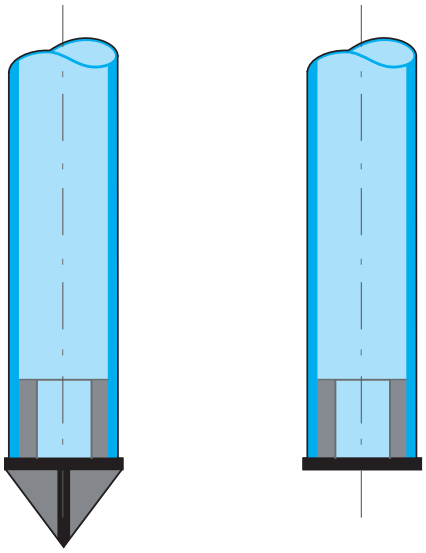
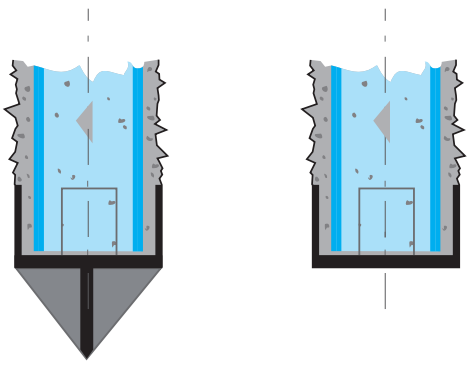


plate: ST52 or higher quality 160/160/20 to 280/280/40

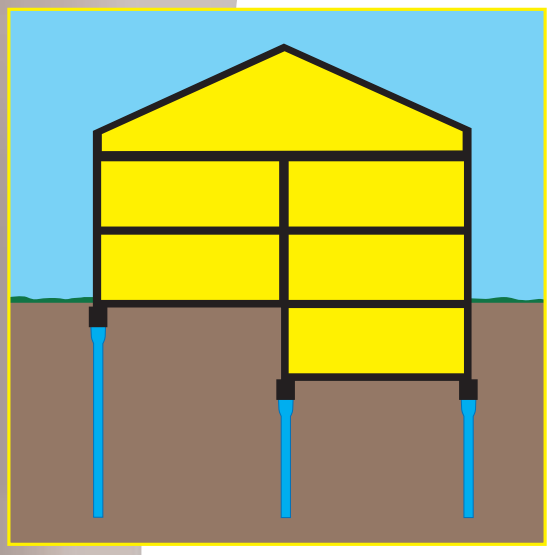


pile shoe for piles without grouting

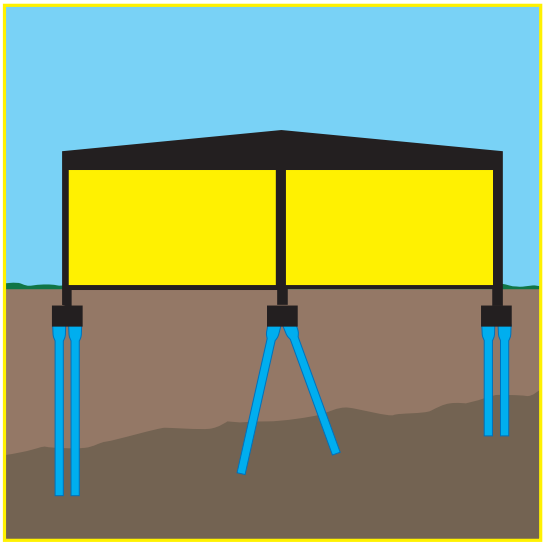


pile shoe for grouted piles

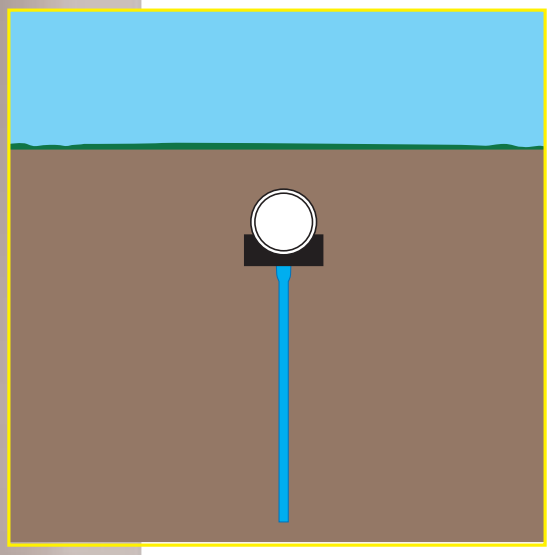
Concrete mortar grouting is carried out during driving.



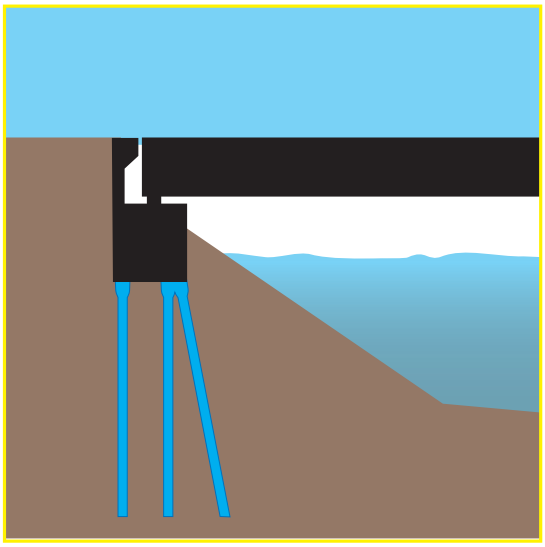
building constructions



industrial constructions



foundations for pipelines



bridges

Examples for the use of HLV® - Piles

Building constructions

Requiring easily movable equipment and only short construction times, the pile system is particularly useful for building foundations between existing buildings in urban areas. The construction of capping beams on the piles saves considerable amounts of concrete, thus increasing the economy of this pile system.

Industrial constructions

The pile system is very useful for supporting prefabricated halls, which nowadays are usually lightweight constructions that are highly sensitive to settling, particularly different degrees of settling. The piles may be directly inserted into small tubular foundations, thus forming building supports which reliably divert wind and earthquake energies into the ground.

Bridges

When casting the foundation of bridge abutments, it is very important to be able to move equipment quickly and easily. Load transfer must be clearly divided according to load components. Moments are transferred to the pile block, while horizontal forces are transferred to inclined piles.

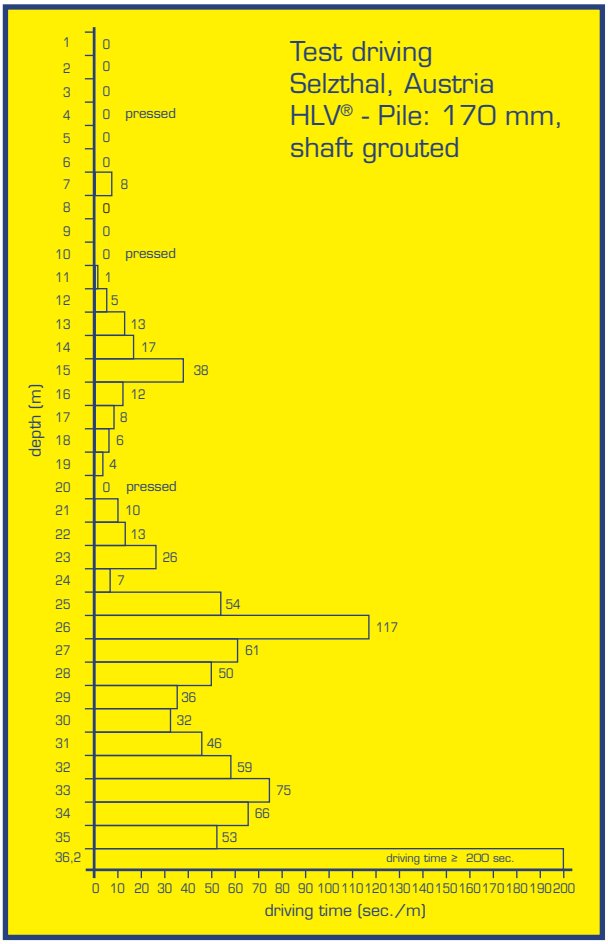
Foundations for pipelines

In soft soils, foundations for water or sewage pipelines are necessary to avoid excessive settling.

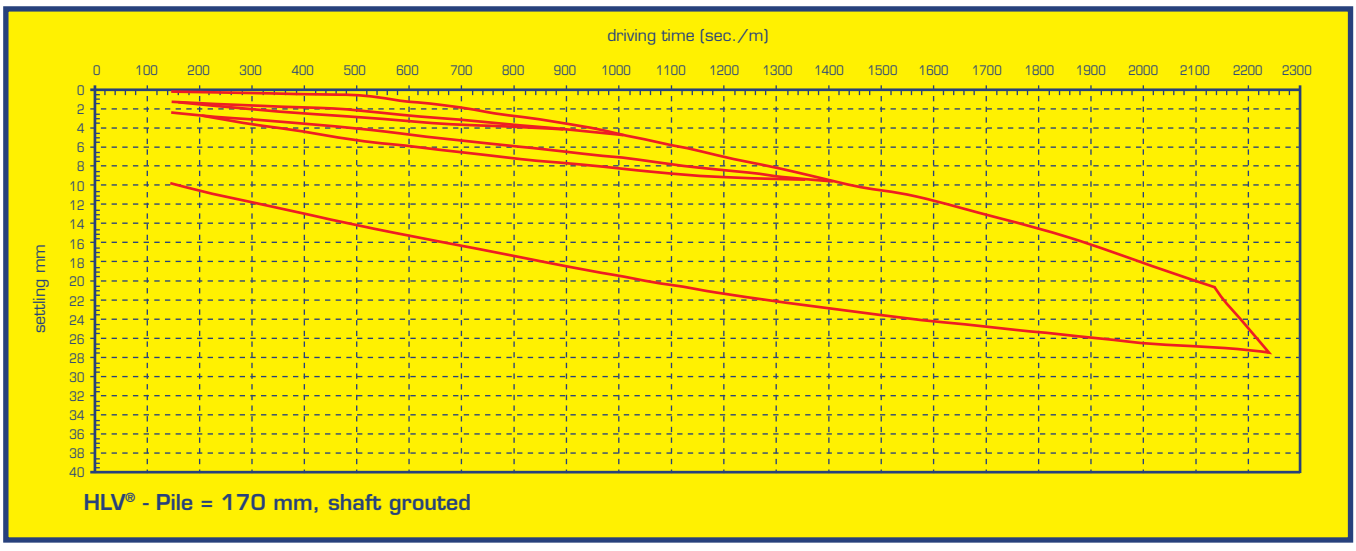
Proof of load-bearing capacity by means of driving criteria HLV® - Piles: Ø 170 mm, concrete grouted Ø 250 mm Service load: 1000 kN

Soil composition in Selzthal, Austria

0.00 = ground level	
	groundwater level
- 5.00	peat
- 13.00	silt, sandy, clayey, organic particles
- 15.50	gravel
- 24.00	silt, sandy with peat
- 36.20	ground moraine rocky silty



Load test in Selzthal, Austria



Determining driving criteria by means of pile load bearing tests

Static load test

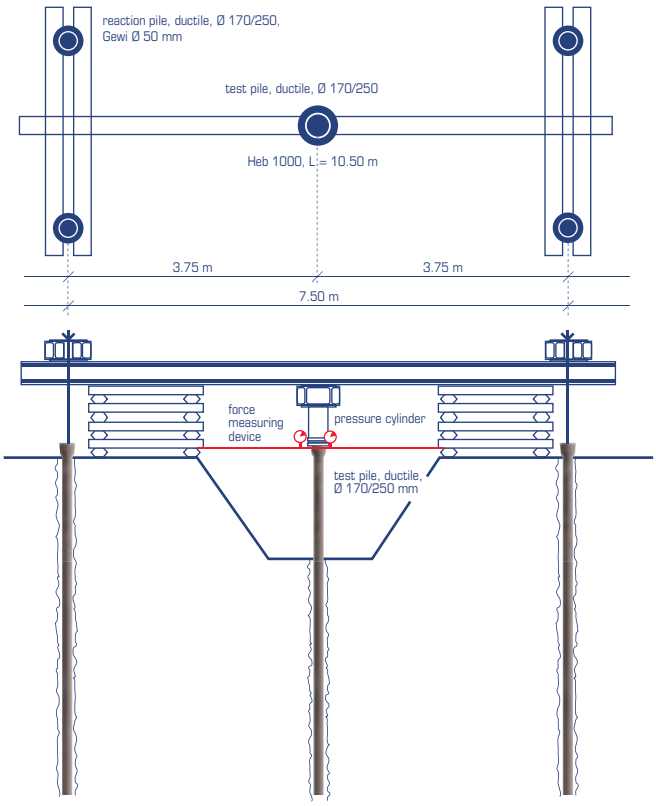
Selected piles are subjected to static load bearing tests to determine the settling behavior under load and to adjust estimated driving criteria.

After constructing, the **HLV®** - Pile is pressed down gradually, using a hydraulic press, while exactly maintaining loading and time increments, until the test load defined by a structural engineer is reached.

The loading steps (test cycles) are determined in cooperation with a geologist or soil expert and have to be individually adapted to the prevailing soil conditions, particularly in waterlogged, cohesive soils.

The test results are implemented in further project planning to optimize the economy and applicability of the **HLV®** - pile system, if possible.

Test arrangement



Laibach/Slovenia

Rottenmann/Austria

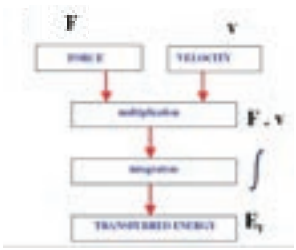
Latest development

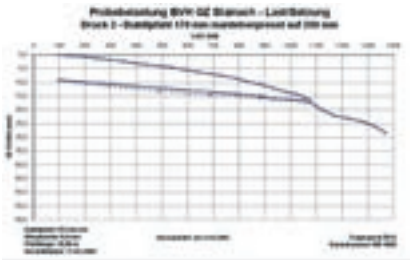
Dynamic driving monitoring

General

As static load tests are very expensive and time-consuming, Grund- Pfahl- und Sonderbau GmbH has decided to develop a test method allowing measurement of both the kinetic energy involved and the soil resistance against driving.

The new method, referred to as »dynamic driving monitoring«, allows fast and cost-efficient verification of driving criteria for the load-bearing capacity of piles that have been found by trial and error before.





Initial parameters

The sensors on the sample detect the acceleration. Simple mathematical integration over time yields the velocity, and further mathematical integration yields the displacement.

In addition, strain gauges measure sample deformation. Taking into account the geometry (diameter and wall thickness) and the E-module of the sample material, the forces existing during driving may be calculated. In a further step, the kinetic energy may be determined.

When preparing the sample, the greatest challenge is to fasten the acceleration sensors and the strain gauges.

The measurements show that when driving HLV® - piles the acceleration may be as high as 1,800 g. As a consequence, the main focus has to be on the quality of the driving hammer.

Future outlook

This development should lead to firm interpretation of measured data with respect to pile service loads, making no distinction between the base pressure and the combined base pressure and shaft friction piles.

Moreover, the driving formula according to Prof. Fröhlich, Austria, now allows the checking of estimated service loads of cast in situ concrete piles of the Zeissl-GPS system conventionally used in Austria.

First results show that when using the test load formula according to Prof. Fröhlich, we are well on the safe side.

Results

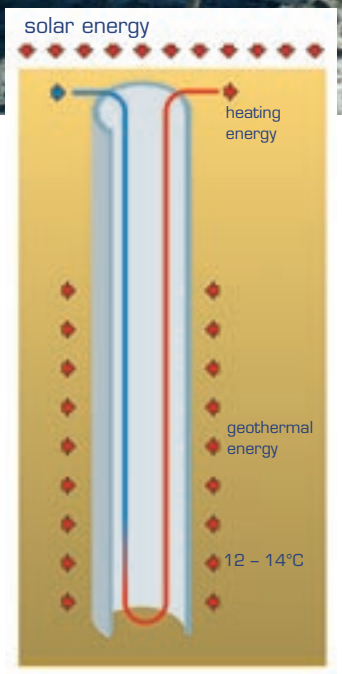
Grund- Pfahl- und Sonderbau GmbH is now able to quickly check the capacity, i.e. the kinetic energy of our driving hammers any time and to adapt it to prevailing soil conditions. Therefore, measurement data can now prove that the piles we produce have the necessary load capacities.

As a »by-product« of this development, we are now also able to carry out dynamic load tests on slim piles up to a service load of approx. 500 kN quickly and cost-efficiently.

As quality management is highly important for us at Grund- Pfahl- und Sonderbau GmbH, we regularly re-check the data using static load tests.

The HLV® - energy pile

A combination of two sophisticated products



Pile foundation as energy producer

The basic idea of the energy pile technology is to extract (geothermal) heat from the soil via the foundation and to provide suitable systems to use it to heat the building. On the other hand, this system may also be used for cooling by dissipating excessive heat into the soil.
In this system, the soil and groundwater may function as seasonal accumulators of energy for cooling and heating.

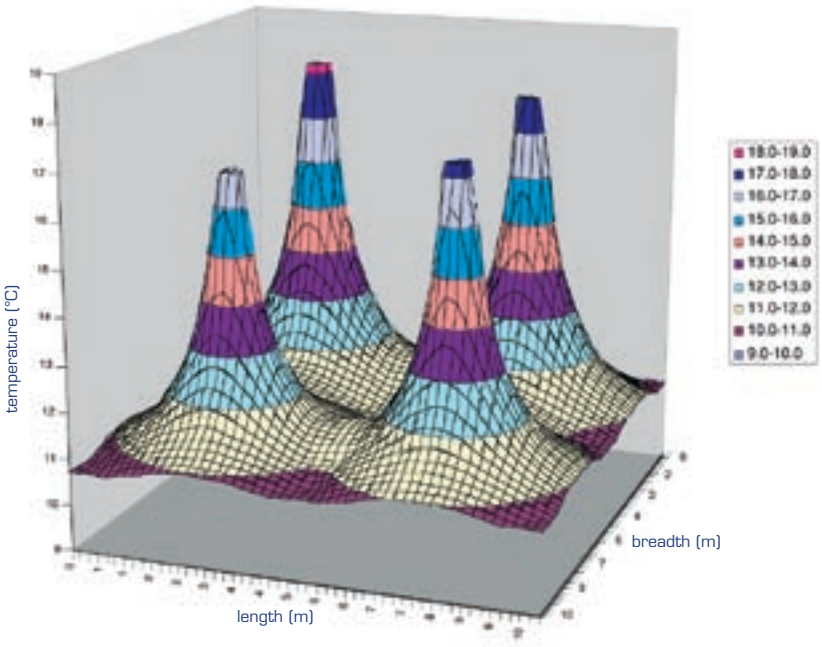
The combination of two sophisticated products

Pile foundations may be used for energy transfer by laying absorber lines into the piles. The company Nägele Energie- und Haustechnik has used this system for decades under the trade name enercret®. Well proven and universally applicable, the HLV® - piles of Grund- Pfahl und Sonderbau GmbH are ideal for such installations.

The use of HLV® - piles and enercret® together combines the advantages of two high quality products.

The **HLV® - energy pile** provides a safe and highly economical foundation system for cost-efficient and eco-friendly production of heating and cooling energy. It is ideal to be used in a wide variety of applications.

Heating and cooling buildings via their foundations



Simulation of temperature distribution in four energy piles operated in series

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