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UP-TO-DATE TECHNOLOGIES IN URBAN CIVIL ENGINEERING AND ENVIRONMENTAL ENGINEERING

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Abstract

An enormous development of building technologies has been initiated in the construction market by the financial restriction increasing the competition. The reasons and aspects concerning the special foundation and environment protectional activity and the trends in the development of new technologies have been analyzed. The actual stage and examples of up-to-date methods and equipment of diaphragm walling, piling and soil consolidation have been detailed and a review of use of PC controlled 'high-tech' applications has been presented.

1. Introduction

In the past 8 to 10 years, development of building technologies was affected by the following factors, keeping in mind the increasing requirements by customers, on the one hand, and the financial restrictions, on the other:

1.1. Increase of competitiveness by cost reduction, boosting of output, applying power saving methods and means, and quality improvement.

1.2. Development of environmentally harmless materials and methods modifying chemical properties of the applied materials and procedures so as to prevent soil, groundwater and air pollution;
Use of environmentally safe machinery and procedures, thereby minimizing the risk to workers and environment.

1.3. In the future, the effects of existing pollutants, in the case of new establishments should be reduced and by creating protective implements for structures, by developing and applying proper materials and technologies.

In the following, a short survey will be given of this kind of developments in a particular domain of civil engineering due to the quoted causes and effects.

2. Trends in the Development of Diaphragm Wall Construction

It is well known that diaphragm walls are constructed for

- load bearing,
- impermeability,
- impermeability-load bearing, etc.

in conformity with structural and functional demands.

In the development of trench perforation technologies, priority is given to the increase of output and the possible dimensions (depth, thickness), and to the frugality by the use of slurry, but much stress is laid on the demand to reduce damaging environmental effects, and on new environmental protection tasks too.

The increase of productivity, extension of depth and geotechnical limits of applicability were much helped by revolving fraising head machine constructions (Hydrofraise).

At present, several firms apply these machines much higher developed than the first generation. The French company SOLETANCHE excels with its machine named 'Hydrofraise', some of which achieve depths to 150 m and a thickness of 3 m, with fraising tools of the needed size, and with slurry mixing and regenerating plants of capacities fitting the increased performance (*Fig. 1*).

The latest development is the 'Hydrofraise Latine', a 'mini' version of the former ones (*Fig. 2*).

Kelly-type equipment with stiff guide bars tends to be outdated and to be replaced by machines constructed with a short Kelly bar fixed to the clamshell suspended on rope. Such machines are manufactured by SOIL MEC, Casagrande, and others, one of the most up-to-date models is SOLETANCHE KS-3000 with a hydraulically controlled clamshell coherent with the short Kelly bar suspended on a rope. The clamshell can rotate by 360° around its vertical axis (*Fig. 3*).

This construction guaranties a high industrial output (8 to 20 sq.m/h) and geometrical flexibility for slurry walls of variable layouts and depths to 40 m, even in hard soils. New generations of Hydrofraise and KS-3000 are computer controlled and equipped with a checking system improving and balancing quality of the end product, the diaphragm wall.

Using mud of the wanted composition, consisting of self-hardening environment-friendly material, these technologies are effective also in environmental protection engineering for isolating soil and groundwater pollutions, for preventive or ulterior separation of dangerous waste deposits etc.

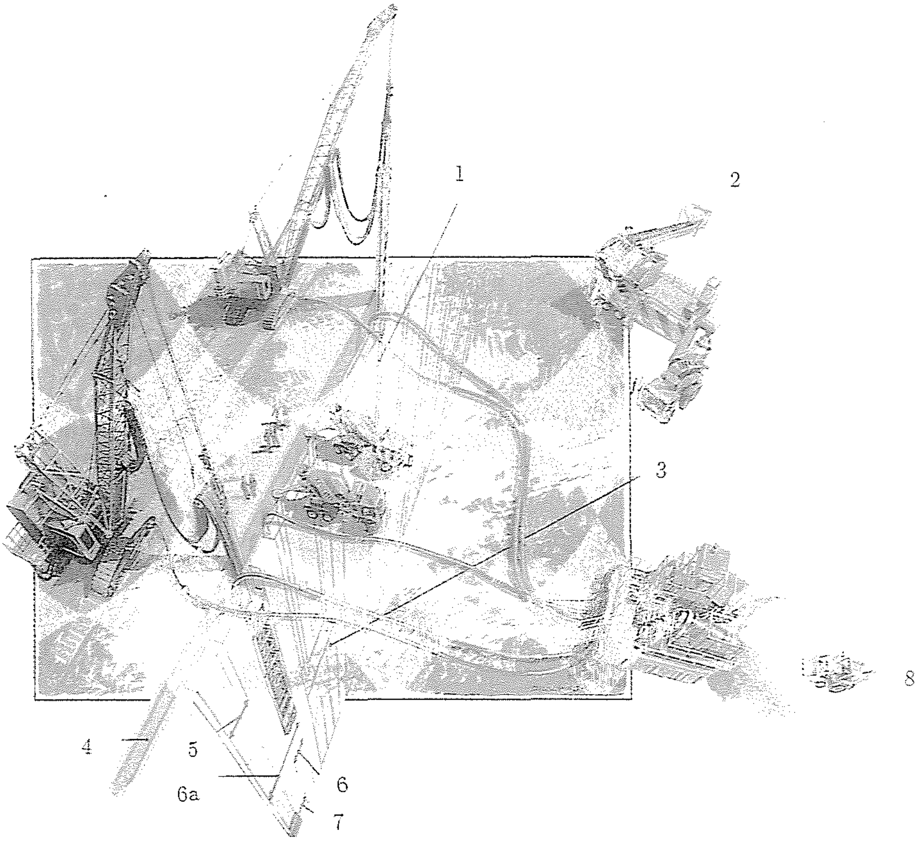

Fig. 1. Process of slurry trench wall construction by means of a Hydrofraise equipment. 1 – secondary wall panels, 2 – slurry mixing and regenerating plant, 3 – casting primary panels, 4 – starting trench with guide walls, 5 – first cut, 6 – second cut, 6a – order of cut for the primary panel, 7 – third cut, 8 – concrete mixer

If the mentioned self-hardening trench materials or trench concretes cannot resist chemical aggressivity of the surroundings, there is a new possibility to apply corrosion-resistant or other chemically resistant plastic membranes to be incorporated into the slurry wall structure by precise technologies providing continuity of sheets between trench units (*Fig. 4*). As a usual solution, watertight trench wall connections can be constructed by incorporating rubber or plastic 'waterstops'.

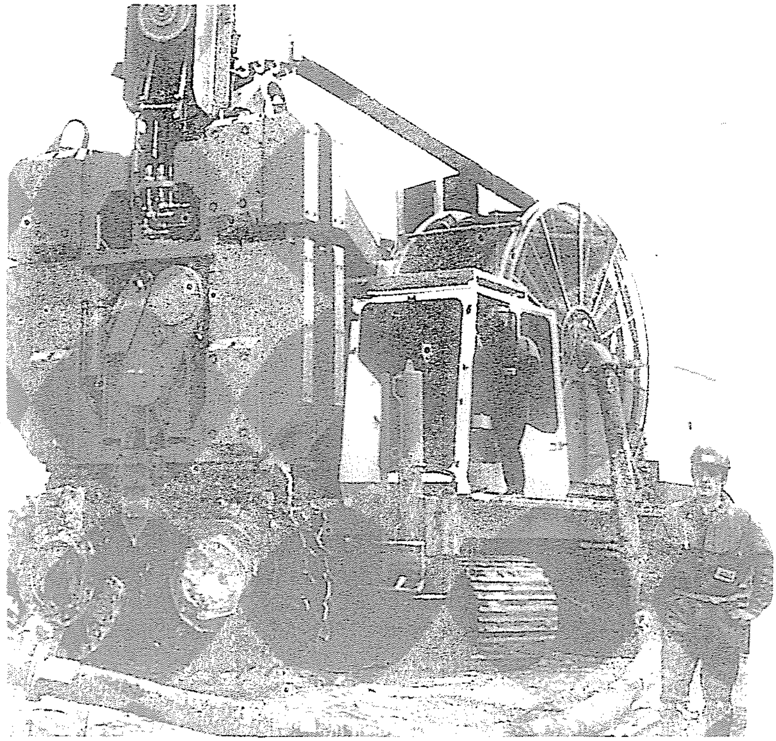

Fig. 2. Hydrofraise Latine equipment

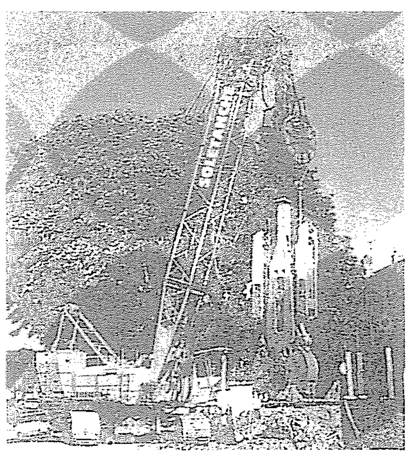

Fig. 3. The KS-3000-type equipment

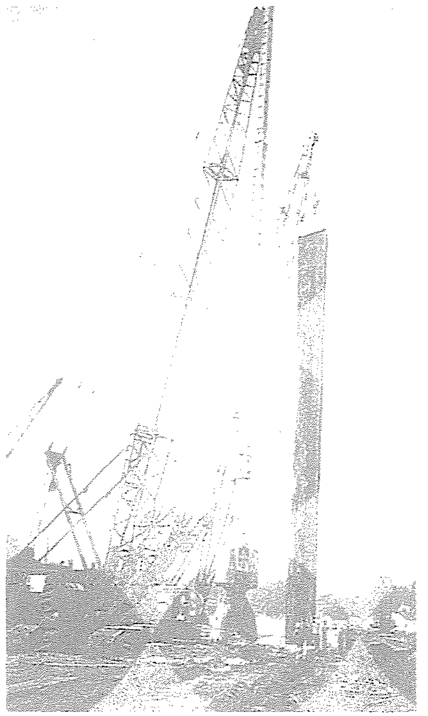

Fig. 4. Environmental slurry wall made with membrane sealing

3. Actual Problems of Pile Driving

In the domain of bored piling, continuous flight auger piles are relative novelely in this country. One of the latest types is made by STARSOL (SOLETANCHE).

In this method, the auger can be somewhat displaced relative to the concreting duct, resulting in more compact piles, fitting better the subsoil, thereby in a higher load bearing capacity for the same dimensions than by the traditional method, and of course, at a higher construction speed (*Fig. 5*).

In the field of small-diameter micropiles, development is represented by 'minimizing' the drilling machinery, thereby piling may be carried out from very small rooms, underground, low interior spaces, much improving efficiency of reconstructing works and extending the range of applicability of micropiles. Of course, development of the grouting techniques is of great importance in this respect too.

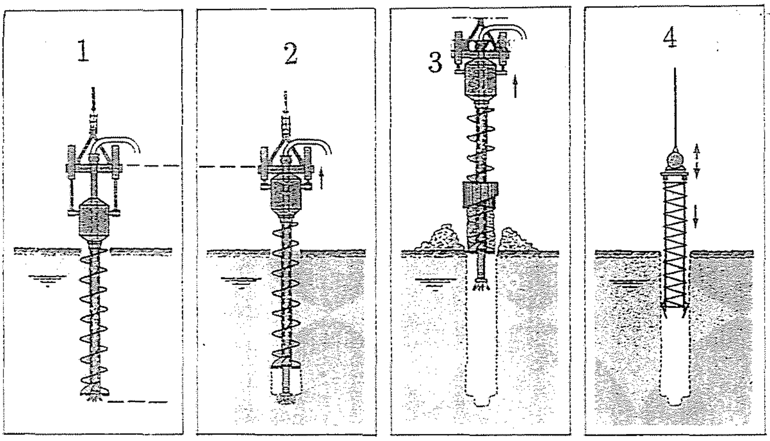

Fig. 5. Scheme of constructing STARSOL piles. 1 – drilling, 2 – start of concreting, 3 – concreting, 4 – arrangement of reinforcement

4. Recent Development in Soil Consolidation

Of course, there are several methods and procedures (dynamic and deep compaction, drains and gravel piles accelerate consolidation, freezing, grouting, jet grouting, etc.) of which here only soil consolidation by jet grouting and by grouting will be outlined.

A common feature of these procedures is that they improve soil defects by pressurized grouting various environment-friendly mixtures under pressure developed recently.

Jet grouting methods are rather popular in this country. They are advantageous because they permit extensive use of various up-to-date grouts in a wide range of soils and rocks.

A recent monojet procedure can be seen in *Fig. 6.* During the construction of a deep basement in a downtown area, the excavation of the working pit showed a soil stratification other than predicted causing unexpected settlements and hazard to surrounding buildings. Therefore the work was broken off and the surrounding diaphragm wall was ulteriorly further deepened for stabilizing the neighbouring buildings and the working pit, as well as for dewatering the building site. Protected by the jet grouted curtain, the working trench was further excavated, and foundation for the construction to be accommodated in it was successfully completed by inserting temporary steel supports and through step-by-step work.

In chemical soil consolidation (by grouting), development is partly due to recent materials of a proper chemical composition free of environmental pollutants as against gels or mixes with organic reagents earlier used, on

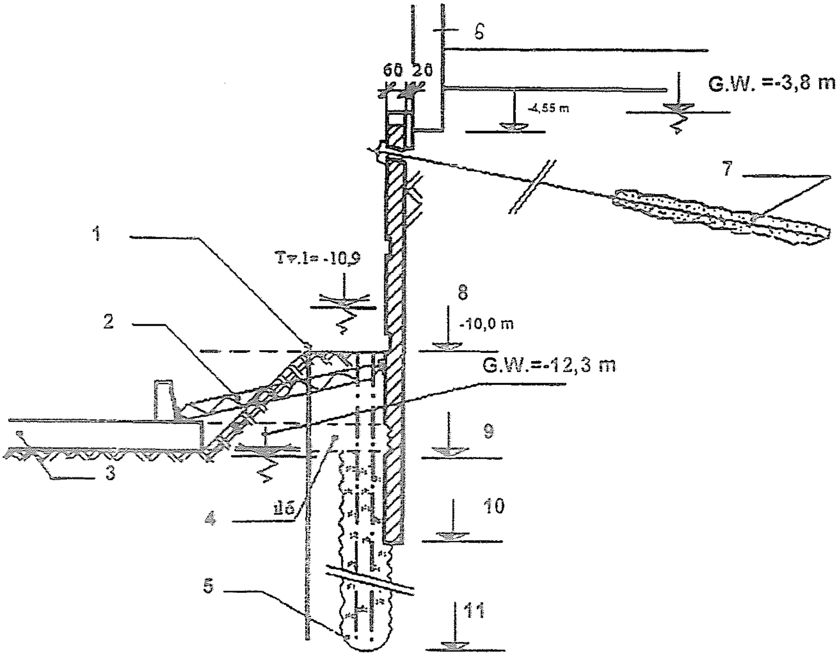

Fig. 6. Example of jet grouting application.
1 – groundwater pressure relief well, 2 – temporary support of diaphragm wall, 3 – r.c. bottom slab constructed at stage I., 4 – r.c. bottom slab constructed at stage II, 5 – jet grouting, 6 – foundation of an existing building, 7 – grouted soil tie-backs, 8 – −10.0 jet working level, 9 – −12.8 top level of jet grouting treatment, 10 – −16.3 bottom level of diaphragm wall, 11 – −21.7 bottom level of treatment

the other hand, due to their low initial viscosity — hence, good grouting properties — they also suit consolidation of fine graded soils.

Of course, development of the drilling technique also increases the range of applicability of grouting, and grouting permits to erect various environment protecting constructions.

In soil consolidation, exact geometrical and geotechnical design of the processes, the safe execution of the proposed treatment, as well as checking of the results are essential.

Computerization offers a lot of new possibilities in design, performance and control checking.

As an example, the most developed SOLETANCHE procedure, SINUS-3 will be presented as a computer- controlled, integrated handling, managing and checking system for preparation, design and execution of grouting works. Its function flowchart is shown in *Fig. 7.*

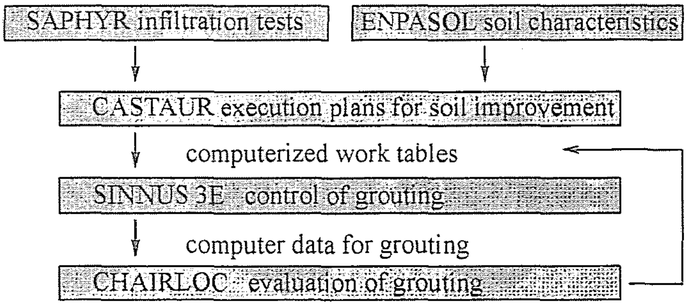

Fig. 7. Flowchart of a computerized grouting system.

First units of the IBM PC or compatible personal computer system are the systems ENPASOL receiving and recording drilling parameters typical of soil strata, and SAPHYR recording data from various water permeability tests in soils.

Relying on these data as well as on various specified design parameters, geotechnical data, geometry, public utilities, etc., the design program system CASTAUR prepares drilling and grouting plans for soil consolidation, taking features of the given equipment and of the environment into consideration. It also produces drilling plans, layout plans and drilling-wise working sheets.

According to design data, the SINUS 3 site control system actuates grouting, while continuously surveying compliance with specified grouting pressures, velocities and quantities, as well as making drilling-wise reports. CHAIRLOCK evaluation system joining the SINUS control system summarizes and checks grouting data and results, if needed, feeding back to the control system, if needed.

It produces various qualifying and statistical records of the performed work, offering systematized valuable information for certification and accounting, on the one hand, and for collecting experience for solving design and development problems on the other hand.

5. Concluding Remark

Finally, we point out that up-to-date technologies require incomparably more professional skill than before, and extreme discipline from all the participants workers and engineers.