Innovative solutions building a new container berth
Solutions innovatrices lors de la construction d'un nouveau mouillage

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ABSTRACT: In order to increase the capacity of a container terminal it became necessary to build a berth for the biggest container-vessels. Building a new berth demands high standards as regards construction and building technology so that an optimum solution in terms of both technology and economic viability can be found.
In a Europe-wide competition efficient companies and/or groups of tenderers were looked for. Among these applicants was then held a „contest of ideas" which aimed at finding innovations, developing company-specific ideas and at concentrating offers of ideas and prices in one procedure. The following constructive options were presented: steel sheet-piling with various installation techniques, diphragm walls (slurry-wall-technologies) and caissons.

RÉSUMÉ: Pour l'extension des capacités d'un terminal, il a été nécessaire de construire un nouveau mouillage pour les plus grands navires porte-conteneurs. La construction de celuici a constitué un véritable défi quant à la conception et à technique de construction, dès lors qu´il s'agissait de trouver une solution optimale, tant du point de vue technique qu'économique.
Un concours organisé européen a permis de découvrir des entrepreises ou groupements de soumissionnaires performants; les concurrents ainsi choisis se sont alors affrontés dans le cadre d'un concours de conception, ayant piur objet la découverte d'innovations, le développement d'idées spécifiques yus entreprises, ainsi que la concentration des aspects idées et prix dans le cadre d´une seule procédure. Voici les suggestions qui en sont ressorties: Rideaux de palplanches métalliques, Construction de rideaux souterrains et Construction à base de caissons fonces.
Les divers modes de construction seront expliqués et évalués des points de vue technique et prix.

1 INTRODUCTION

The increas in cargo handling at the container terminal „Burchardkai" requires an increase of capacity by building a new berth. The most effective solution could be realized by transforming an existing promontory into a berth.

Requirements for the berth were an effective lenght of 300 m and a width of 60 m. Due to the situation at the location three sections of the new berth had to be constructed (fig. 1):

1. re-structuring 35 m of an existing berth (fig. 1, block Nr. 1)
2. building the main section of the berth of ca. 300 m (fig. 1, block Nr. 2-11) and
3. designing the head of the new berth (fig. 1, block Nr. 12)

The essential boundary conditions for the design of the new berth were:

- difficult soil conditions with a glacial layer of detritus and boulders up to 1,2 m
- the considerable depth to harbour bottom of nearly 25 m, tide-independent waterdepth for modern container vessels
- design of a cross-section that reduces scour formation due to bow- and stern trusters.

2 SOIL CONDITIONS

The upper layers of the Hamburg substratum consist of filling materials, mainly sand from NN + 6,0 m to NN - 4,0 m, which reflect the influence of the civilization of the last few centuries. Under this there are layers of post ice-age sands to a depth of NN - 22,50 m and these are followed further down by boulder clay. The transition region between the post ice-age sands an the boulder clay is formed by a layer of sand, gravel and boulders which was in the area of the new sheet piling and would obviously cause considerable problems during piledriving. (fig. 2)

3 TENDER PROCEDURE

In order to find an optimum solution in terms of both technology and economic viability, a special aproach was chosen. First, efficient firms and/or groups of

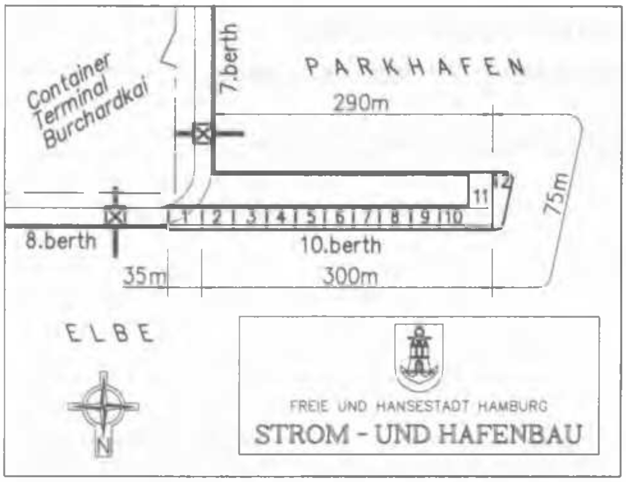

fig. 1: situation

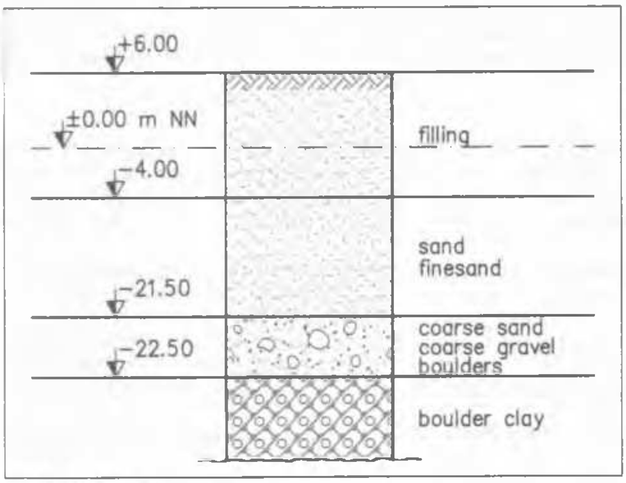

fig. 2: Soil profile

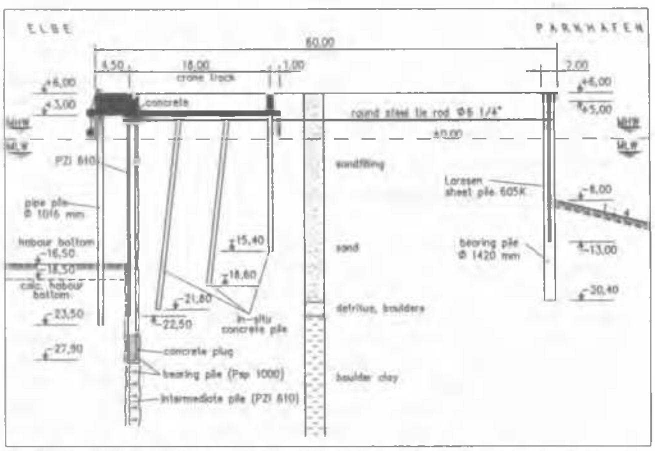

fig. 3: steel sheet-pilling, positioning by means of slurry-wall technology

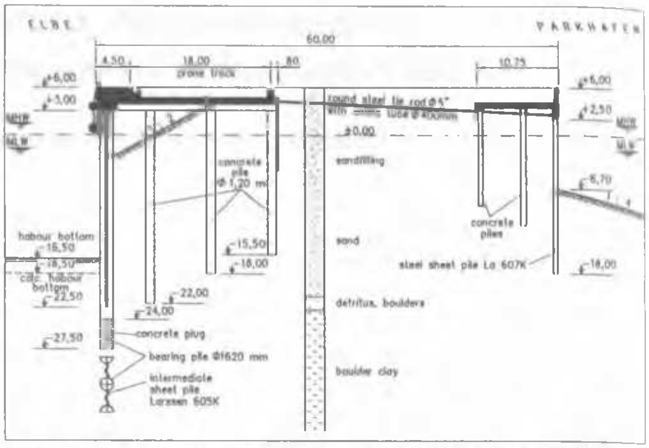

fig. 4: steel sheet-piling, positioning in bentonite-supported predrilled holes

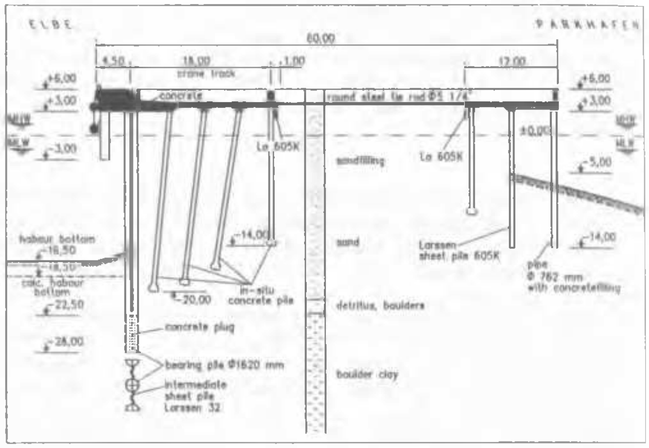

fig. 5: steel sheet-piling, positioning by means of large-diameter drilling gear

tenderers which could present satisfactory solutions for this constructive task were looked for by means of an EU-wide publication. 7 efficient groups of tenderers were then selected from the participants of this competition.
In the following second step, the „contest of ideas", suitable solutions should be found. The aims of this contest were to initiate innovations, to develop company-specific ideas, to link the concept to a fixed-price offer and to minimize the principal´s/tenderee´s work load by placing an order for the entire project. For the „contest of ideas" the following terms were stipulated:

- clear and final definition of the framework for the planning

- definition of the basis for design and static with due allowance for innovative ideas

- structured list of required performances which allows comparative assessment of the offers.

4 CONSTRUCTIVE SOLUTION

Basically, five different constructive options with differing installation methods were offered which can be presented as follows:

4.1 steel sheet-piling, positioning by means of the slurry-wall technology

Combined steel sheet-pilling is positioned into a previously built trench which is filled with a bentonite-cement-suspension

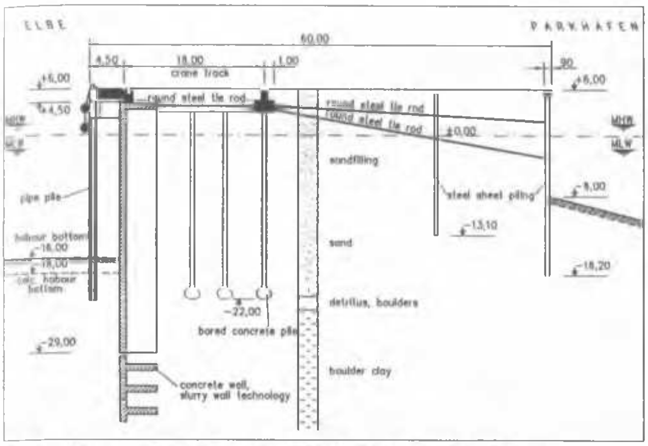

fig. 6: Concrete sheet-piling positioned by slurry wall-technology

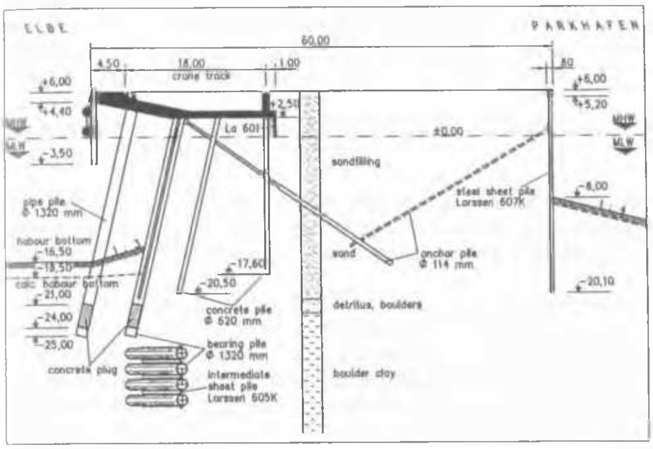

fig. 7: Inclined steel sheet-pilling with pipes

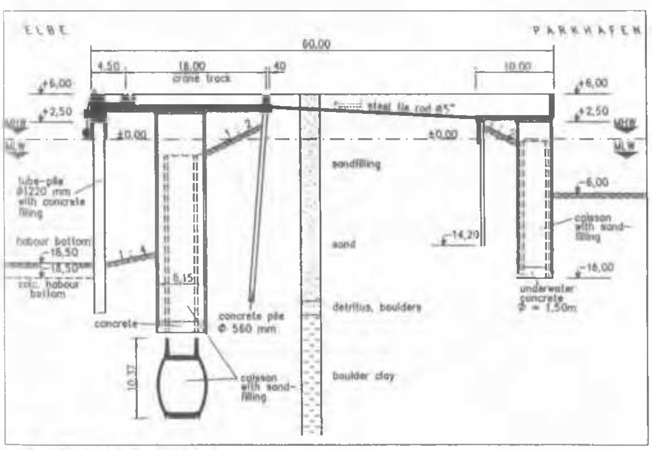

fig. 8: Caisson foundation

(fig. 3). The use of the slury-wall-technology allows to dig a continuous trench in which also bigger boulders can be chiseled and brought to the surface.

This design takes into consideration the demand for damage-free positioning of the main wall. The suspension is enriched with cement so that, after some time, it acquires the firmness which corresponds to the indices of the surrounding soil. In order to distribute vertical loads, a concrete beam is placed in the base area of the load-bearing elements. To reduce the risk of scour formation the steel sheet-pilling ist shifted backwards. Anchoring is effected at the opposite sheet-pilling.

4.2 Steel sheet-pilling with pipes

4.2.1 Positioning in bentonite-supported pre-drilled holes

This design provides for pre-drilling only for the bearing piles (fig. 14). By reaming the core and filling in bentonite it becomes possible to remove soil from under the foot of the pile. The gaps between the bearing piles are then prepared by secondary pre-drilling and replacement of soil for the easy positioning of the intermediate elements. By shifting back the wall, the risk of scour formation is reduced. Anchoring is effected at the opposite sheet-pilling.

4.2.2 Positioning by means of large-diameter drilling gear.

In this design the final bearing piles are positioned by means of large-diameter drilling gear and a very elaborate guiding system (fig. 5). During this process the soil is removed; also bigger boulders can be brought to the surface.

The sheet-piling is not shifted back.

4.3 Concrete sheet-piling positioned by slurry-wall-technology.

This design provides for a back-shifted concrete wall positioned by means of a slurry-wall-technology (which, in one alternative, is T-shaped) which is anchored to a steel sheet-piling on the opposite side of the promontory (fig. 7).
The slurry-wall-technology allows easy penetration of the layer of detritus and boulders so that also big boulders can be removed easily. Therefore, the afterwards positioned concrete wall can be placed damage free and tight.

4.4 Inclined steel sheet-piling with pipes

Inclined sheet-piling is an interesting variation to reduce scours caused by propeller jets (fig. 7). The inclination deflects the current more to the surface so that less energy reaches the harbour bottom. However, positioning the inclined element requires special equipment designed to minimize the risks of penetrating the difficult layers.

4.5 Caisson foundation

The design provides for caisson foundation which is shifted back by ca. 7 m. The oval, 2,5 m high reinforced concrete prefabricated elements are concrete-filled at the bottom and filled up with sand (fig.8). The back-shifting reduces the risk of scour formation. However, sinking the caissons requires a high level of precision so that considerable risks had to be assumed due to the difficult soil conditions.

5. TECHNICAL AND FINANCIAL ASSESSMENT

It can be said that, basically, the overall conception and costs of the project were the decisive factors for placing the order; these were mainly determined by the costs for the 300 m long main section. The costs per quay-meter of this mainsection are presented in the figures. These costs base on tender-prices, related to the constructiv elements of berth side.

An order was placed for solution 4.1 (fig. 3) which optimized technology and price. Solution 4.2/2 (fig. 5) was excluded because the sheet piling was not shifted back and, therefore, offered no protection against scour formation. Solution 4.2/1 (fig. 4) is obviously more expensive due to the competitive situation but does not offer more than solution 4.1.

Solution 4.3 ans 4.5 (fig. 6, 8) give a good answer to the problems of soil conditions and expected obstacles; solution 4.5 has never been executed in Hamburg soil-conditions so that this more expensive option did not ofer any advantages.