Pannier Type Reinforced Earth Cofferdam for River Dredging

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ABSTRACT: In order to place the textile reinforced belts and to complete their package under deep water, a pannier-type reinforced earth cofferdam is designed, which can fit the construction under deep water. The panniers to construct the cofferdam are made of various kinds of geosynthetic materials. The work cost of cofferdam is only one-seventh of that of the original design proposal.

1 INTRODUCTION

Taipuhe River Project is one of the ten key projects for the harnessing of Taihu Lake Basin. Taipuhe River, the golden waterway of navigation, is not only the main discharge outlet in Taihu Lake Basin, but it also supplies Shanghai with water in dry years.

The riverbed of Taipuhe River section, which is 40.7km long within the boundaries of Jiangsu Provinsce, should be lowered by means of hydraulic dredge to -5.00m from the original elevation of . 0.00m (Wu Song), so as to meet the needs of flood discharge. In fact, the implementation of this scheme means that the cross section of the riverwill be expanded by the area of the original section, which brings about the resettlement of a great quantity of earth ramoved by hydraulie dredge. In this case, it is suitable to construct dykes and cofferdams around the lakes along the river, in which the dredged earth is piled.

Therefore, the construction of cofferdam for mud clearing site of Taipuhe River is to build cofferdams or dykes on soft foundation. This is one of the difficult engineering problems in Taipuhe Riverway Project, and it has great influence on the work cost and schedule to choose the correct construction method.

Originally there are three design proposals for the cofferdam of mud clearing site.

A.Cofferdams are constructed through lake dyke, by using soil taken from dry land;

B.Cofferdams are constructed by riprapping stone pyramids;

C.Cofferdams are constructed by bamboo piles.

The work costs of the first two schemes are high, furthermore the working periods needed are so long that they can't meet the requirement set by project bidding, As for the third scheme, it is proved by practice that the stability of the cofferdam is hard to be maintained when the water level is rather high.

Based on the analysis and investigation of the cofferdam's requirements and working conditions, the scheme of pannier- type reinforced earth cofferdam is chosen among the alternatives. The

reasonable selection of each kind of geosynthetic materials whose characteristics are brought into full play, makes the cofferdam possess the functions of original designed one. Hence it can reduce the volume of earthwork and riprapping quantity, cut down the construction cost and shortan the construction period as well.

The pannier-type reinforced earth cofferdam is composed of following materials. PVC hard tubes are used as skeleton of the cofferdam to support and to spread the reinforced belts so as to satisfy the demand for the rigitity in construction. Reinforced belts and Netlon network are used as reinforcer(tensile element)so as to withstand the lateral earth pressure of cofferdam, to increase the soil modulus and to limit the deformation of cofferdam. Filter textile is used for silt insulation and water draining from soft foundation so as to accelerate the consolidation of soil. The erosion-resistant network filled with broken-stones is used to break water and protect cofferdam.Soil collected by clamshell dredger from riverbed is used as the filling material. Namely, a compound integrity composed of geosynthatic material, filling soil and broken stones constitutes the reinforced earth cofferdam project to meet the need of mud clearing site, sea Fig 1.

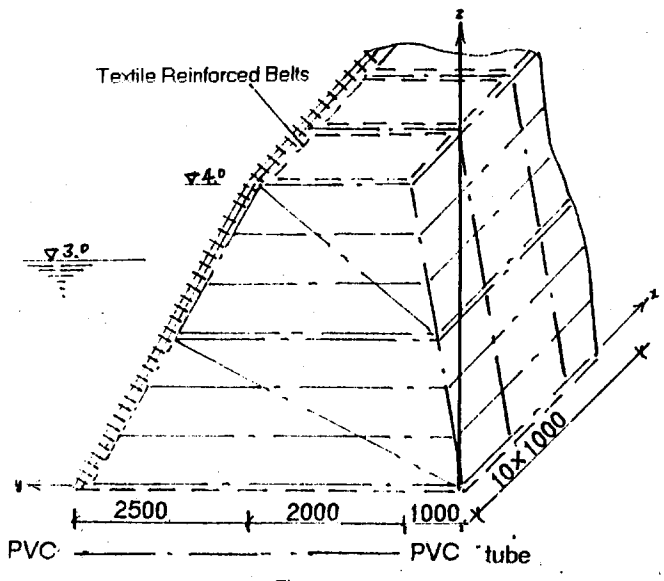

Fig.1

Reinforced earth is a kind of composite material consisting of geosynthetic material and soil, which is similar to reinforced concrete composed of plain concerte and reinforcement. The tensile strength of soil is very small.In order to increase the shear strength of soil and to keep the relative stability of soil, the reinforced belts made by synthetic fiber are laid in soil to bear the lateral tension in earth.

Generally, the reinforcing beits made by geosynghetic materials are laid horizontally and then they wrap and saperate soil so as to increase the shear strength of soil, see Fig 2.

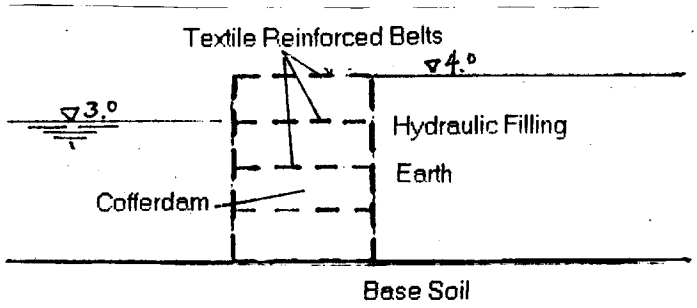

Fig.2

However as cofferdam project is constructed under deep water, it is difficult to place the reinforcing belts horizontally and to accomplish the package. In order to complete the subaqueous construction of cofferdam smoothly, the panniers of the pannier- type reinforced earth cofferdam are prefabricated on river back, they are then positioned sunk, and filled with soil, The cofferdam is finally constructed and the reiforeing pattern, horizontally placing of belts, is changed intn vertically placing.

2 COMPUTATION

The fracture of reinforced earth cofferdam may be caused by outer failure or inner failure. The outer failure means that damage occurs out of the reinforced zone and the innor failure means damage within rainforcod zone.

2.1 OUTER FAILURE

The reinforced earth cofferdam can be treated as gravity retain wall, when the possibillty of outer failure is being investigated. The deaige conditions are shown in Fig 3,4 and 5.

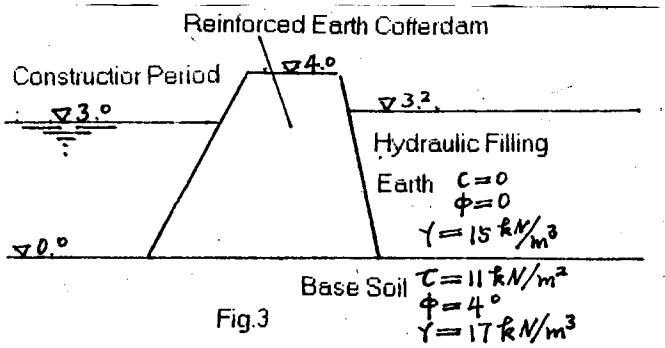

Fig.3

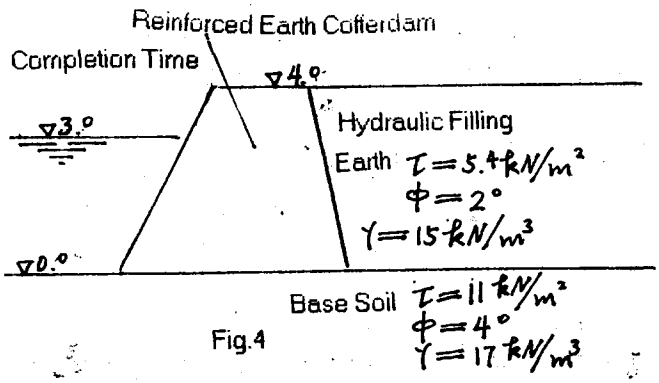

Fig.4

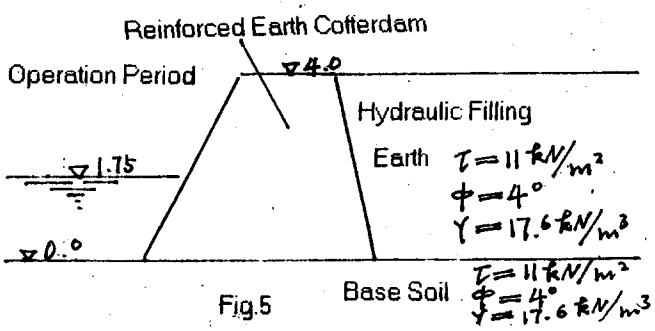

Fig.5

Rasults of Factor of Sufety (FS)

Stage	Construction Period	Compiction Time	Operation Period
Basement Slding Failure	2.25> [1.05]	1..68 >[1.05]	1.28>[1.05]
Circular Slip Failure	1.50> [1.10]	1.384>[1.1]	1.294> [1.1]
Toppling Failure	6.00> [1.50]	4.66 > [1.5]	5.29> [1.5]

2.2 INNER FAILURE

Inner failure of reinforced earth cofferdam is checked by using limlting equilibrium analysis. For the convenience of construction, evenly - spaced and vertically-placed package pattern of reinforcing is adopted. Therefore, the whole cofferdam has the same constitutional form of reinforcing. The safety factors of reinforeer for design tensile strength meet the requirements proposed by J.P.Goure of France, i, e,for polypropylene. f_{rr}>5(temporary loade); f_{rr}>10 (permanent loade).

3 CONSTRUCTION

The pannier-type rainforced earth cofferdam is 4m high. During construction, the panniers are arranged in two layers, each of which is 2m high and 10m long. One layer is overlaid by the other after the paniers are prefabricated on river bank. A segment of panniers such formed weighs 360kg, and 7--10 men are needed to remove it to the edge of river.Then filling-soil is sunk in the panniers which are positioned under water. Soil-filling is carried out in two steps. First, the cofferdam is evenly heightened to 3.0m by the back- filling of soil collected by clamshell dredger from riverbed. Then the soil within cofferdams is filled in the same sequence to 4.0m. Construction in such way can make the soil-filling in cofferdam possess certain degree of consolidation so as to raduce the lateral pressure caused by filling earth.

Filter textile covers the mouth of horizontal PVC tube, the skeleton of cofferdam. Water in hydraulic filling area can be drained off through the fillter. PVC tubes are placed along the axis of dyke and distributed densenly and evenly from the bottom to the top of cofferdam so that the clean water can be drained off, the grains of hydraulic filling soil will

be evenly distributed and the cost caused by the dredging of back-silted soil will be reduced.

Netlon erosion-resistant network is laid on the side towards riverwater, in which broken-stones of 20cm thick are filled so as to resist erosion caused by wave and people. Seversl months after the completion of the network, its surface will be covered with vegetation which can beautify the environment and protect the Netlon engineering network from aging as well.