Earth Reinforcement, Ochiai, Yasufuku & Omine (eds) © 1996 Balkema, Rotterdam. ISBN 90 5410 833 9

The use of geotextiles to improve the structural stability of fill materials for Bandar Abbas runway construction

H. Behbahani
Iran University of Sciences and Technology, Narmak, Tehran, Iran

ABSTRACT: The present paper is a summary of studies done concerning land limitation problems encountered in the process of extension of Bandar Abbass-airport runway No. 2 on Persian Gulf bed by the use of a geotextile . The international Bandar Abass airport has two runways; runway No. 1 is long enough to accept large aircraft, but runway No .2 is small and unpaved.
In accordance with the industrial growth of the country an active intentional airport should be seriously considered as an important part of transportation facilities .Therefore due to land limitations of a parallel runway toward the Persian Gulf by the use of geotextiles was considered as a suitable solution to soil reinforcement . Different investigations were carried out before the design of the embankment .
The results of different measurements obtained from consolidation recording, made it possible to design and reinforce the soil by using favourable geotextiles.

1. INTRODUCTION

Due to economical considerations and land limitations, the construction of a second parallel runway for Bandar Abass international airport was considered along the Persian Gulf bed by means of fill materials.
The soil layers, consisted of , soft dark clay. fine silt clay, and shelly sandy clay on marly materials.
In order to obtain structural stability of the fill materials, the use of soil reinforcement was considered necessary . Two different reinforcing techniques have been proposed.
1- Base reinforcements by geotextiles.
2- Slope reinforcement by geogrids.
The embankment was designed with reinforcement of various layers of geotextiles to overcome foundation stability problem in the sub soil (1).

2. FIELD EVALUATION

The soil investigation covered 77 samples obtained by soil boring operations using a continuos flight auger and drill, mounted on a barge. The area under investigation was 1000 × 600 m in dimensions, with the boreholes all lined up in square grids.
Fig 1 . illustrates, different soil layers encountered in the site. Assuming a 2 meters average water depth , the thicknesses and type of all soil materials are according to the same figure 1.
The results of the main geotechnical properties obtained from laboratory and field tests are shown in table 1.

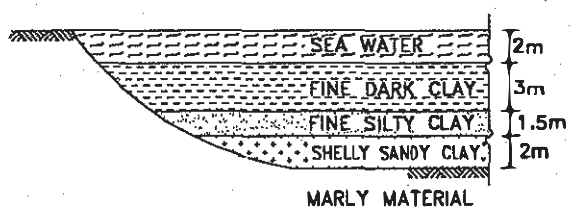


Figure 1: Formation of different layers of the Gulf bed.

3. FILL MATERIAL SETTLEMENT

The main parameters to be considered for selecting the type of fill materials were stability and settlement of embankment.
The lower layers of embankment consisted of granular soil, which tend to have a faster rate of settlement compared with cohesive soils.
As a result of low coefficient of permeability of the fine grained soil of the Gulf, bed, dissipation of pore water pressure is very slow and therefore, the consolidation may take few years from the time of construction and may last till the end of the runway useful life.
Strain is also a cumulative effect of grain distortion, particle rolling and slipping. The consequence of such strain is reduction in void ratio or void volume which can only take place when a pore fluid is dissipated (6).
The soil profile and ε vs. log P curve is shown in figure2.

$$P=78 \text{ Kpa}$$
$$A=H.\ \Delta P$$
$$\Delta P=A/H=113.7$$
$$\Delta H=C'c.H.\ LOg\ (P+\Delta P)\ /\ P \qquad (1)$$

ΔH=0.85

%=(0.85/5.5)*100=15.5

P=Pressure, KPa

Po = Overburden pressure, KPa

ΔH= Expected settlement, m

H= Stratum thickness , m

A= Area of diagram, m^2

C'c= Consolidation parameter, m^2

ΔP= Applied pressure, KPa

Table 1: Main geotechnical properties of soil sublayers

	water	soft hard clay	fine silty clay	shelly sandy clay	marl
Depth below (m)	0-2	2-5	5-6.5	6.5-8.5	> 8.5
Density kg/m^3	-	1600	1700	1200	-
Water content %	100	72	53	40	-
Shear strength Cu N/mm^2	-	8-11	14-17	20-25	-
Compressibility C'c	-	0.58-0.71	0.32-0.71	0.15-0.30	-
Angle of internal friction degrees	-	10-15	28-38	30-40	-

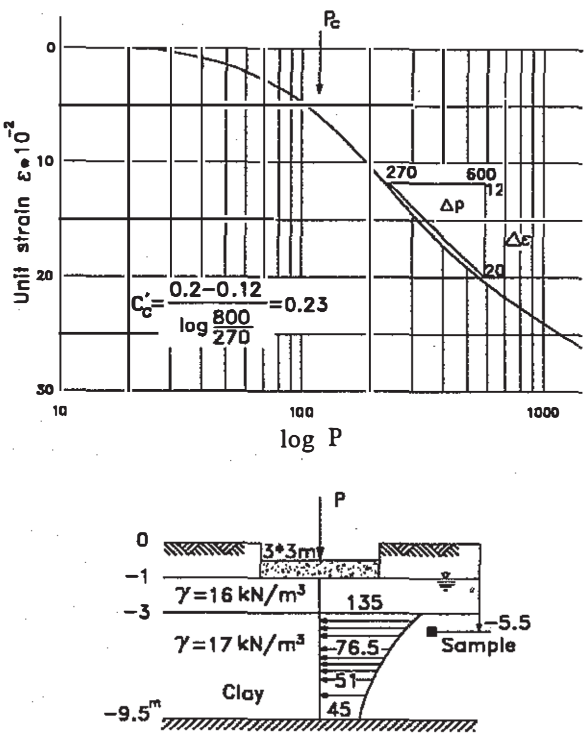


Figure 2: Soil profile and ε versus log p curve assume C'c is assumed constant in the entire thickness of 9.5 metres.

4.ESSENTIAL REQUIREMENTS FOR GEOTEXTILE FABRICS

The following requirements were considered essential for the job.

1- Non- wowen fabrics with continuos filaments of polypropylene mechanically bonded to form a homogenous sheet.

2- The quality of polymer should have been such that a retention of at least 90% of original tensile strength while exposed continuously to natural sunlight in the Persian Gulf conditions.

3- Resistant to long term contact with damp cementitious substrates or acid or alkali leachate solutions in the P.H. range of 2-13.

The selected geotextile fabric obtained met the requirements as shown in table 2;

Table 2 : Properties of geotextile fabrics

Tensile strength (R)		44/31 kN/m
Elongation at break (E)		80/120 %
Puncture strength (CBR method)		4000N
Effective opening size (DW)		%7 mm
Vertical permeability	2 kN/m^2	0.3 cm/s
under pressure	200 kN/m^2	0.05 cm/s
Vertical water flow	2 kN/m^2	581/m2/s
Under pressure	200 kN/m^2	0.6 cm/s
Horizontal permeability	2 kN/m^2	0.6 cm/s
within sheet under pressure	20 kN/m^2	0.3 cm/s
horizontal water flow	2 kN/m^2	113 l/m.n
within sheet under pressure	20 kNm^2	56 l/M.

As it can be seen from Table 2, selected geogrids had high tensile strength with integral joints which were neither welded nor wowen.

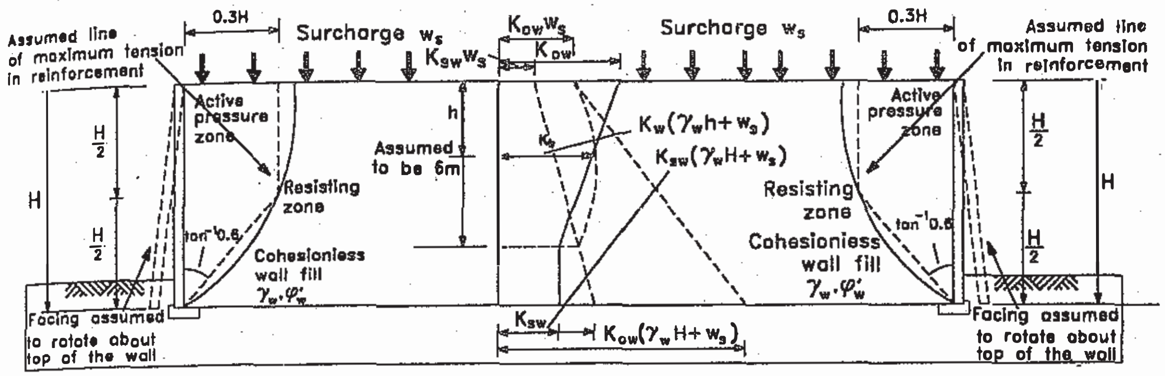


Figure 3 : Vertical reinforced soil structures assumption

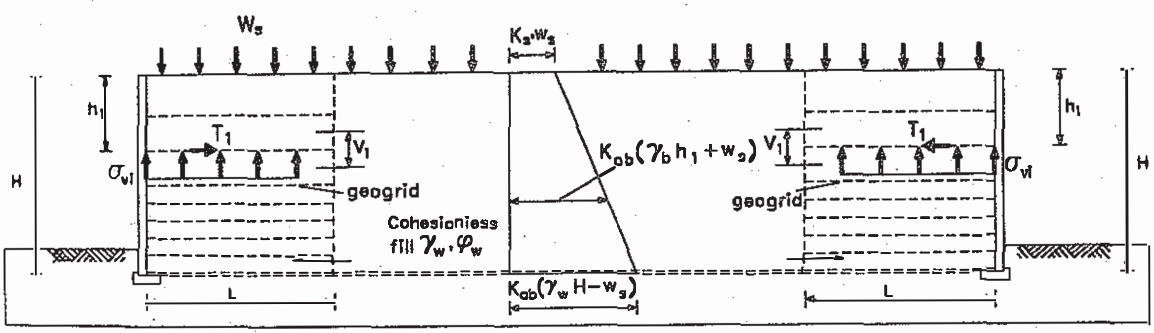


Figure 4: Meyerhof distribution of pressure

5. THEORETICAL ASPECTS OF CALCULATIONS OF EARTH PRESSURES.

Coherent Gravity Method was used for evaluation of internal stability of vertical reinforced soil structures .
The method is regarded as a tie- back method since it is based on an analysis of horizontal forces due to lateral earth pressures that need to be resisted by tension reinforcement tie - backs.
The method is based upon the idea that the geogrids interlock and interact with the surrounding cohesionless fill to resist pull - out failure.
The mentioned method assumes (Fig 3) that the stress of the reinforced mass varies from at rest at the top, to an active stress down at a critical depth. The dotted line in figure 3, divides the soil mass in to two zones, illustrating the line of maximum tension in the reinforcement.
For the calculation of bearing pressure, the Meyerhof distribution was used (Fig 4).

6. CONSTRUCTION TECHNIQUES

The runway profile including the layout of geotextiles and geogrids and the fill materials are shown in figure 5 When the depth of embankment is low in comparison to its width, the circular sliding is no longer the most critical. Considering these conditions, the geogrids were applied in different layers with combination of walls supporting embankment against sliding slopes along a circular slip circle. When the soil is compacted over the grids, each transverse rib acts as a separate anchor point. This enabled the full grid load to be transferred to the anchor ribs through joints . Up to six layers of geogrids were applied to wall facing and embankments behind them. The geotextile fabric was placed by immersion over clay .The immersion took 2-3 hours after its imbibition with out ballastin. The geotextile rolls (130 m long * 2.5 m wide), were assembled by sewing in the form of panels of about 3000 m^2 and accordion folded over the intermediate construction walls supporting embankment. These were then pulled over the water by means of towing barges and spread in a single phase.

In order to speed up the consolidation of compressible layer, on top of the mats a layer of sandy material ,30cm thick, with 0-4 mm in particle size was laid.
To complete the fill, granular material, 0-250 mm in size and 2-3m in thickness, were spread in equal thicknesses of 30 cm. The materials making up the basic immersed layers were poured by means of loader from floating pontoons. Fill materials above the water level was made up by rocky materials in the similar way to the traditional land embankment methods. The positioning of different soil layers and geotextiles are shown in figure 5.

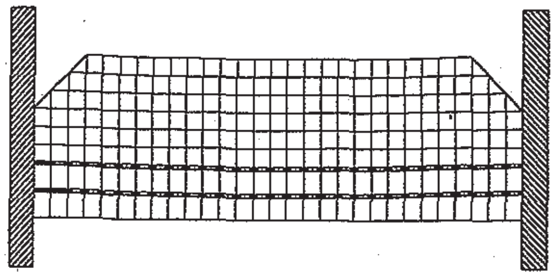


Figure 5: Position of geotextiles

7. RESULTS AND DISCUSSIONS

Geotextiles improved different properties of the fill materials. The longitudinal profile in figure 6 shows the compressible layer located under the runway center line, which exhibits a uniform deformation behavior. This uniformity clearly demonstrates the important role of geotextiles.
To measure the settlements, several recorders were placed by means of plungers, directly on the geotextile fabrics.

8. CONCLUSIONS

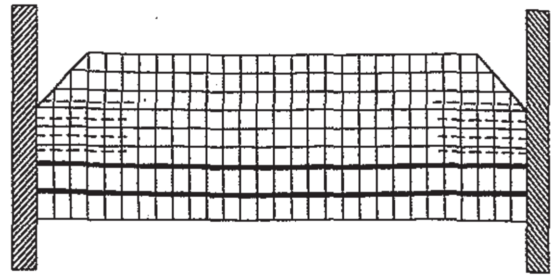
1- The use of a non woven geotextile fabric over fine dark clay allows more effective completion of filling under water.

2-Use of non woven geotextile fabric limits settlement by penetrating to the clay material.

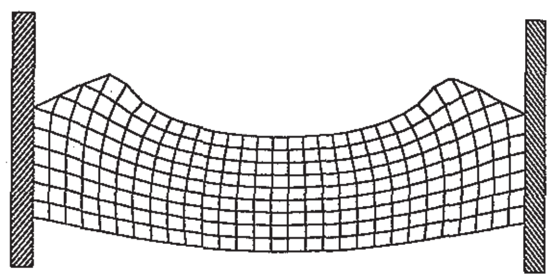
3-Use of non woven geotextile over fine clay material provides uniform distribution of stresses induced by embankment and also prevents over consumption of material.

4-Use of geotextile fabric made it possible to reduce the amount of fill material in a proportion of 5 to 10 percent if penetration stops.

5-The vertical wall facing associated with horizontal laiers geogrids reinforcement carries tension as a result of the self-weight of the fill, the surcharge and vertical line load.



(a) Deformation without geotextiles and geogrids



(b) Deformation with geotextiles and geogrids

Figure 6: Uniform deformation obtained using geotextiles

9. REFERENCES

1.Fluet J E, Geotexile testing and the design engineer, ASTM, USA, 1987

2. Bonaparte, R and et.al, Soil reinforcement design using geotextiles and geogrids, U.S.A

3. Polyfelt, Guide lines for the selection and specification of geotextile embankment and road based specification and drainage and hydraulic filter, April 1991.

4. Pagotto, A and et.al, Design and construction of geogrid reinforced embankment over waster material

5. Tensar, Guidelines for design and construction of reinforced soil retaining walls, October 1991.

6. Bowles,J.E. Physical and geotechnical properties of soils, New York: Mc. Graw-Hill book company.