EFFECT OF SILT QUANTITY IN LOCAL SOILS ON THE HYDRAULIC PERFORMANCE OF GEOTEXTILES

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ABSTRACT
This paper focused on studying the effect of silt quantity in soils on the performance of synthetic fabrics called Geotextiles, which is a standard set by the U.S. Army Corps of Engineers to evaluate the degree of fabric clogging. Certain hydraulic relationships were established to determine the effect of silt quantity in soils on the performance of Geotextiles. From the results we found out a relation between silt quantity and gradient ratio, so the increase of silt quantity in soils leads to increase gradient ratio and that causes increase clogging degree of the synthetic fabric (Geotextile).

Keywords: geotextile, synthetic fabric, silt quantity, performance, permeameter, gradient ratio.

INTRODUCTION
Geotextiles are made from poly-propylene, polyster, poly-ethelene and polymide (HOLTZ R.D., 1990) [1] the most used as a protection for soils from erosion and used as filters between soil layers.

Hydraulic properties of geotextiles are those that relate directly to filtration and drainage functions of geotextiles. Hydraulic properties fall in to two general categories:

a) **Filtration:** Pertaining to the filtration or separation function of a geotextile when used to replace graded aggregate filters in subsurface drains.
b) **Drainage:** Pertaining to a geotextile's ability to transport water within its plane when used as the drain replacing aggregate or sand as the water conductor.

The filtration function of geotextile requires that it have pore size sufficiently small to retain soil particle and permeability adequate to allow the free escape of seepage from the protected soil.

The hydraulic conductivity of geotextiles is determined by measuring the flow rate of water through the geotextile in a direction normal to the plane of the fabric (WILLIAMS N. D, 1989) [2].

Clogging behavior must be evaluated in a soil-fabric system that simulates use conditions. A Gradient Ratio Test is one such method where a soil-fabric permeameter system (HORZ R.C., 1986) [3] is used to monitor soil-fabric interaction.

The objective of this research is to find out the relation between silt quantity in the soils and performance of geotextiles.

MATERIALS AND METHODS

Experimental apparatus
In this study, one type of geotextile type (Bidim U-24) and five samples of local soils were tested using a gradient ratio test (GRT), device developed by Author Calhoun, from the U.S Army Corps of Engineers (HORZ R.C., 1986) [3] to measure filtration and clogging behavior in soil-fabric systems.

The experimental work was made in the Hydraulic Laboratory, Department of Water Resources Engineering, University of Mosul.

Samples of soils used in the tests
a) Dohuk region sample
b) Mosul region sample
c) AL-Khazir region sample
d) Karbala Sample
e) Rashidya sample

Table-1 describes the type of soils used in the test, and the quantity of sand, silt, clay and specific gravity for each soil.

Table-1. Types of soils subjected to the test with the quantity of sand, silt, clay and GS.

No.	Test sample	Type of soil	Sand (%)	Silt (%)	Clay (%)	Gravel (%)	Organic materials	Specific gravity GS
1	Dohuk sample	Clayey silt	40	23	26	11.0	0.0	2.54
2	Mosul sample	Silt clayey	16	57	26	0.0	1.0	2.66
3	AL-Khazir	Sand	90	0.0	0.0	10.0	0.0	2.61
4	Karbala sample	Silty clayey loam	23	52	23	2.0	0.0	2.573
5	Rashidya sample	Silty loam	25	55	20	0.0	0.0	2.66

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Type of geotextile used in the test

The Geotextile type Bidim U24 is used in the test with the classifications listed in Table-2.

As shown in Figure-l (GICOT O., 1982) [4], the device consist of (10cm) diameter cylinder, provided with two orifices, the higher orifice responsible to provide the device with a water from constant head tank and the lower orifice to discharge the outlet water.

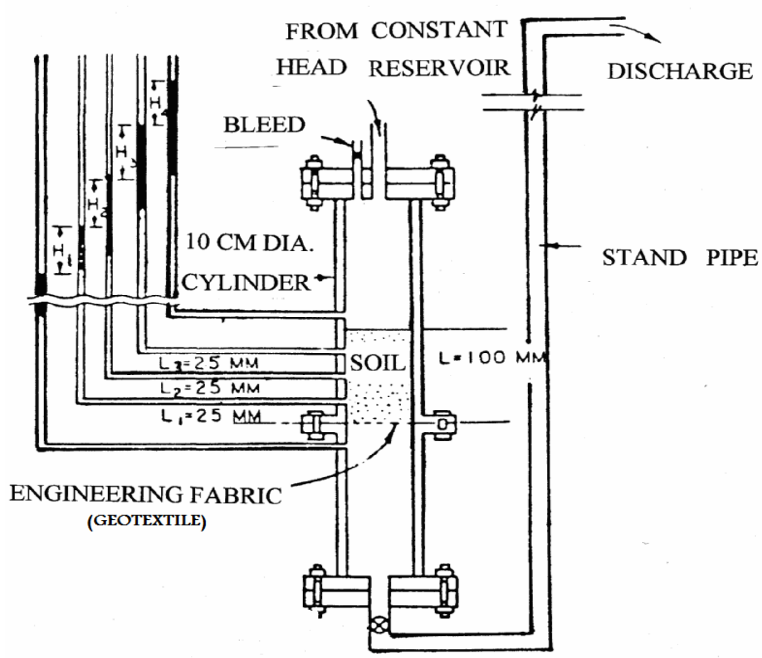

Figure-1. Corps of engineer type gradient ratio test device.

The procedure calls for placing the geotextile and 100mm of a selected soil in a 100mm diameter permeameter apparatus. Five piezometers are placed at various heights above the geotextile in the soil, as well as below the geotextile to monitor gradient ratio (GR) at a different levels.

A constant head of water is applied to cause flow through the system under specified hydraulic gradients.

Head losses are measured at each piezometer location at regular time intervals upto 24 hrs. (Carrol R.G & Jr. 1992) [8]. The gradient ratio values reported are calculated from measurements taken at 24 hours. The test in the device stay for a time at least 45 days, so we can monitor the clogging happened in the geotextile through measure level of water in each piezometer.

The gradient ratio (GR) was found out, by compute the hydraulic gradient through fabric plus the adjacent 25 mm of soil divided by the hydraulic gradient through the adjacent 50mm of a soil. (GOURC J.P., 1990) [5]. This equation set by the U.S. Army Corps of Engineers to evaluate the degree of geotextile clogging.

Table-2. Classification of Geotextile used in the test: Type Bidim U24.

Trade name	Type	Raw material	Thickness (mm)	Weight (gm/m^2)	A.O.S (micrometer)	Permeability (m/sec)
Bidim U24	Non-woven geotextile	Polyster 100 %	2.0	--	125	0.0007

The gradient ratio was computed by the following formula.

$$GR = \frac{H1/L1}{(H2 + H3)/(L2 + L3)}$$

Where

GR = Gradient ratio (dimensionless)

H = Head of water (cm)

L = distance between piezometers (cm)

Calhoun (JAMES E., 2004) [6] established a maximum acceptable clogging ratio of 3.0 based on these and subsequent clogging test evaluations.

RESULTS AND DISCUSSIONS

The experimental work found out the hydraulic gradient ratio for the soils related with the fabric as listed in Table-3.

The U.S Army corps of Engineers established a maximum clogging ratio of 3.0 as acceptable ratio used to measure filtration and clogging behavior in soil-fabric system. So in the test, AL-Khazir, Dohuk and Karbala samples with the fabric refer to a good performance for the fabric. But Al-Rashidya and Al- Mosul samples with gradient ratio equal to 3.61 and 8.18 refers to a bad performance for the fabric.

The results from Table-3 classified the samples of soils related to the degree of permeability as shown below:

(i) Sample of AL-Khazir soil with the geotextile refers to a High permeability with zero silt quantity.
(ii) Sample of Dohuk soil with the geotextile refers to a medium permeability with medium silt quantity (23%).
(iii) Sample of Karbala soil with the geotextile refers to a medium permeability with medium silt quantity (52%).
(iv) Sample of AL-Rashidya soil with the geotextile refers to a low permeability with a High silt quantity (55%).
(v) Sample of AL-Mosul soil with the geotextile refers to a low permeability with a High silt quantity (57%).

Table-3. Results of gradient ratios and discharges.

No.	Type of soil	Type of Geotextile	Gradient Ratio	Higher and lower discharge (cm^3/min)
1	Dohuk Sample	Bidim U24	1.5	28.0 - 6.0
2	Mosul Sample	Bidim U24	8.18	14.5-1.5
3	AL-Khazir Sample	Bidim U24	0.83	190.0-3.66
4	Karbala sample	Bidim U24	2.85	78.0-3.63
5	Rashidya sample		3.61	4.0-1.0

Figure-2 (KOERNER R.M., 1987) [7] shows flowing water through soil and synthetic fabric, show also the clogging happened in the particles of the fabric due to fine grains of soil.

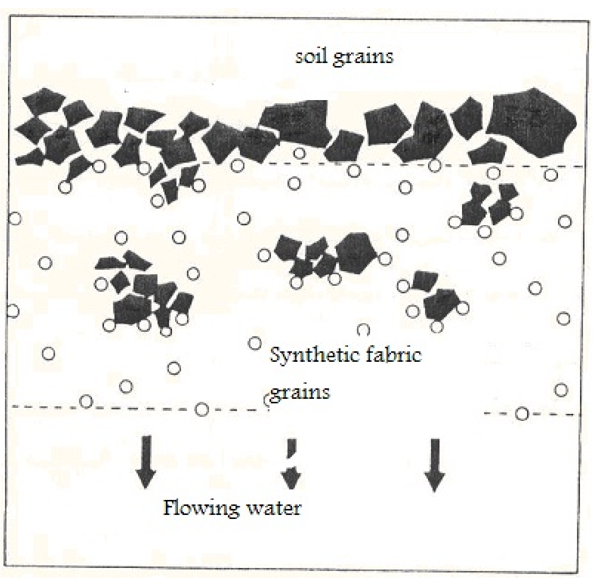

Figure-2. Flowing water through synthetic fabric subjected to soil.

The research obtained a relation between silt quantity and Gradient ratio, as shown in Figure-3.

From this relation we can note that the excess of silt quantity in the soils results an excess of Gradient ratios or clogging degree of Geotextile, due to excess of fine materials quantity that entering through the openings of the geotextile.

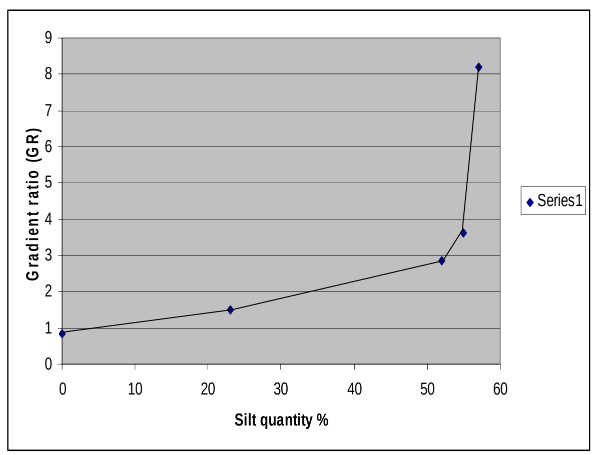

Figure-3. Relation between gradient ratio and silt quantity for soils subjected to the experimental tests.

CONCLUSIONS

We found from this study a relation between silt quantity in soils subjected to the experimental tests and the efficiency of Geotextile. So the increase of silt quantity in soils lead to increase Gradient Ratio (GR) and that causes increase clogging limit of the Geotextile. This lead to reduce efficiency of Geotextiles.

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