Journal of Engineering Sciences, Assiut University, Vol. 36, No. 1, pp. 61-71, January 2008

STUDY ON THE EXISTENCE OF DISPERSIVE CLAYS IN SOME SCOUR REGIONS IN ASSIUT

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(Received November 25, 2007 Accepted December 27, 2007)

There are many parts along the river Nile embankments that are exposed to scouring or erosion of the soil. This action of scouring is dangerous for the river embankment and also for the human activities along the river embankment. This erosion or scouring is a result of many factors that together or sometimes individually affect this process. These factors are generally classified into two categories, one category is the velocity, energy, and direction of water flow and the other category is the surrounded soil type. In this study, the existence of dispersed clay soil, which is considered a dangerous factor in the piping or erosion process, is observed.

1. INTRODUCTION

The dispersive nature of certain clays in the nature is an important and fundamental contribution to geotechnical engineering and particularly to the art of building embankment dams, and also with small extent, in the erosion processes in rivers and canals. The dispersive clays which cannot be differentiated from ordinary erosion-resistant clays by the routine civil engineering tests, erode rapidly in slow moving (or even quite) water by individual colloidal clay particles going into suspension. This fact that there is such an enormous difference in fine grained soils with similar index properties allows new insight into the behavior of dam or river embankment subjected to a concentrated leaks [6,1] which cause the failure or scouring of the river embankment.

The various origins of dispersive clay are not well known. It can exist in flood-plain deposits, slope wash, lake bed deposits and loess deposits. In some parts, it has been found that the clay stone and shale's laid down as marine deposits have the same pore water salts as dispersive clay and their residual soils are dispersive.

Dispersive clays have been red brown grey (some are nearly white), yellow and all transitions among these. Many deposits of dispersive clay studied are in flat flood plains or gentle rolling topography with low relief and smooth, relatively flat slopes. Many excavated channels for irrigation, and also nature stream channels that traverse dispersive soil areas are badly damaged by severe tunnel and gully erosion of the banks and degradation of the bottom. Liang Zhiyon *et al*. [5] studied the scour in the channel bed of the lower Yellow River. The river changes tremendously during flood seasons because of great sediment that were collected there and caused a great scour in the channel banks. The variation of scour and silt in Neijiang river at Dujiangyan has an essential influence on the maintenance, water-sand-division of the project, [8].

Scour at bridges is the first cause of bridge collapse in the United States. Many researches have been performed to improve the prediction of scour depths in coarse-grained soils, but little have been done for fine-grained soils. Starting in the early 1990s, the scour rate in cohesive soils-erosion function apparatus (SRICOS-EFA) method was developed for fine-grained soils [2,4].

1.1. River Nile Scouring

Stability of river banks is controlled by many factors such as bank height, bank slope, soil properties, and water level [7] as follows:

Bank height:

It may be changed by bed degradation, increase of the river velocity or the effect of moving barges. Material deposited on top of the bank leads to the same results as bed scour.

***Bank slope*:**

Due to channel meandering, helical currents are generated and cause scour of the bank under the water surface. As scour Develops, banks cave and fail leading to lateral shifting of the channel.

Soil Properties:

Irrigation water applied to soil near a bank, changes the properties of the soil. Seepage water moves some soil particles and creates small passages in the soil and cause weakening of its structures.

***Water Level*:**

During the periods of low flow in the river (winter period), the groundwater starts to seep to the river, while during the periods of high flow the river recharges the soil, thus changing the soil properties [7].

Local scour occurs when the capacity of water to carry sediment is greater than the incoming supply of sediment as the case of Nag Hammadi Barrage on the River Nile [3]. One of the main causes for local scour downstream of hydraulic structures is the length of time the maximum head is retained in a dam. In this case, the water velocity increases and the water soil interaction begins in different ways.

2. PLAN OF THE PRESENT STUDY

Three sites were chosen where there is a larger scour in the river Nile in Assiut as shown in the Nile map Fig. (1). Three samples are extracted from each site at a depth equal to or more than the water level in the river. The samples are taken from open pits using hand auger with its natural water content, bulk density. The classification tests are carried out on samples such as liquid limit and plastic limit and also field density. Also using standard proctor test, the optimum water content and also the maximum dry density are obtained. The soil in the first site is found to be brown clayey silt with traces of sand and in the second site is found to be slightly dark brown clayey silt. In the third site, the soil is brown clayey silt. The index properties tests are applied on each sample and the results are summarized in Table No. (1) and Fig. (2).

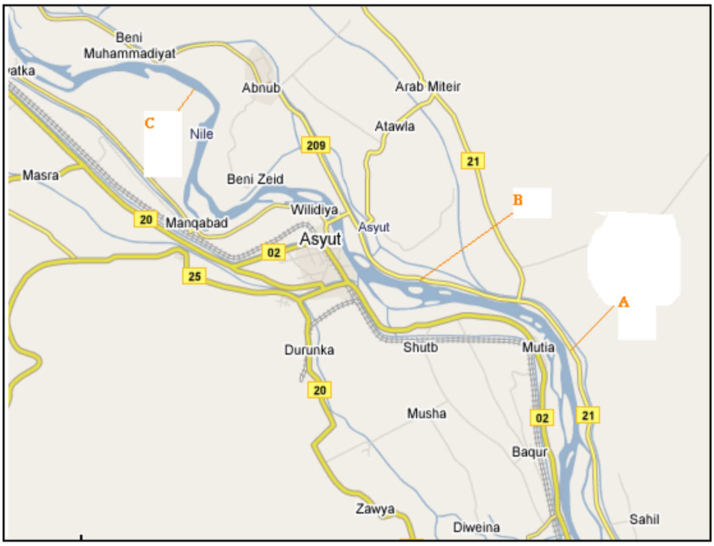


Fig (1) The river Nile map around Assiut city

Table (1) Soil classification results

Site	Specific gravity	Liquid limit	Plastic limit	Op. water Content %	Max. dry density	%<N200
A						
A1	2.66	55	25	14.00	1.95	60
A2	2.68	50	30			
A3	2.67	56	31			
B						
B1	2.7	45	30	13.50	1.80	40
B2	2.7	48	30			
B3	2.7	41	27			
C						
C1	2.65	60	30	1.88	1.88	55
C2	2.65	55	28			
C3	2.65	56	35			

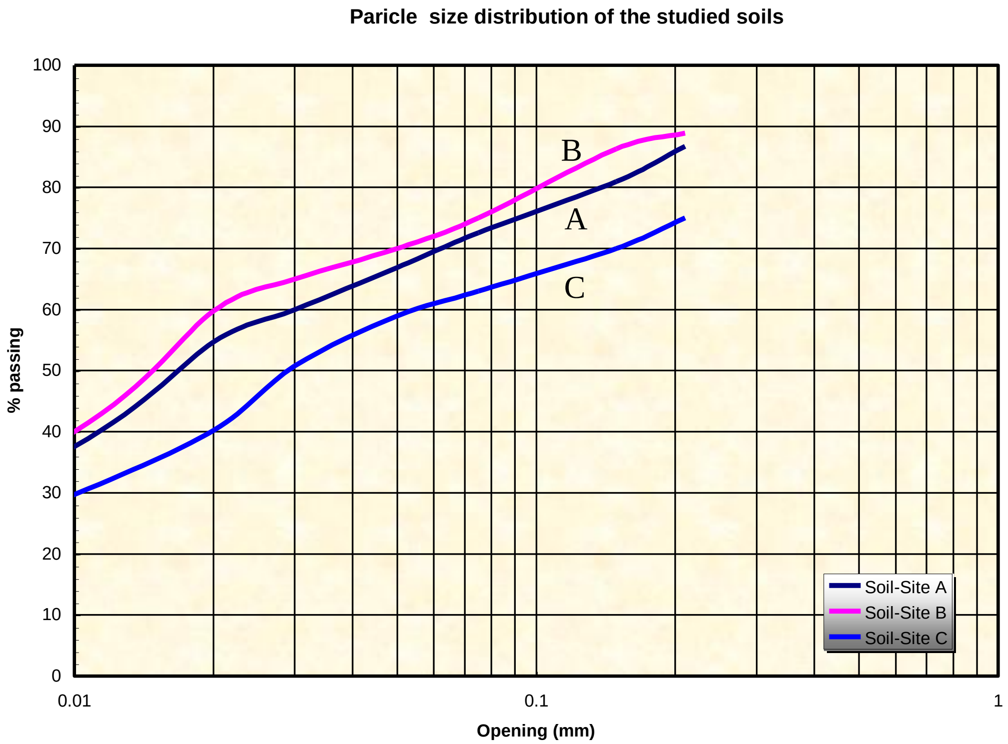


Fig (2) The particle size distribution for soils A, B and C

3. DISPERSION TESTS

The dispersive test methods provide a qualitative indication of the natural dispersive characteristics of clayey soils [2]. Problems of potential erosion are found in inland waterways, unprotected road cuts, drainage ditches, channels, embankments and other surfaces from which vegetation has been removed. The resulting erosion and water sediment restrict the capacity of the drainage system and great amounts of water are lost by seepage and channel instability. It is generally agreed that for design of embankments and earth dams and other structures where erosion of fine grained soils is a potential problem, special laboratory tests are to be made to determine whether the soils involved are in their dispersive or non-dispersive state in nature [1]. Four basic laboratory tests should be made on each soil specimen:

1- The pinhole test,
2- SCS dispersion test (test of dissolved salts in pore water),
3- The double hydrometer test, and
4- The crumb test.

The four tests give consistent results for most soils. They are simple and inexpensive and are enough sufficient for distinguishing between the dispersive and non-dispersive soils [1].

In the United States of America, a laboratory testing was done to determine the dispersive characteristics of typical clay soils from two sites near Houston, Texas. The tests included the crumb test, the Soil Conservation Service Laboratory Dispersion Test SCS (double hydrometer test), chemical analysis of pore water, and the pinhole test. With a few exceptions, each of the four types of tests showed good reproducibility. The pinhole test results were not affected by variations in compaction moisture content, from three points dry to three points wet of the plastic limit. The four types of tests were found to be in excellent agreement for dispersive or non-dispersive clays.

3.1. Classification of Dispersive Tests

The dispersive tests which executed in this study are:

1-The pinhole test

Figure (3), shows the Pinhole test apparatus. Distilled water is caused to flow through a 1.0 mm diameter hole (x) punched in a 25.4 mm long specimen of clay. Initially, the water is caused to flow under a hydraulic head of 50 mm of water. The principal differentiation between dispersive clay and ordinary erosion resistant clay is given by the results of the test under 50 mm of water head. According to Sherard [6], for the dispersive clay, the flow emerging from the specimen is visibly colored with colloidal cloud and does not clear with time. Within 10 min the hole enlarges to about 3 mm (3x) or larger and the test is completed. For the ordinary resistant clays, the flow emerging is completely clear or becomes completely clear in a few seconds and the hole does not erode. Table (2) summarizes the classification of the pinhole results.

Table (2) Categories of pinhole test results according to Sherard [6]

Classification of individual test results	Classification of soil
D1 and D2	Dispersive soils; fail rapidly under 2-in (50.8-mm) head
ND4 and ND	Intermediate soils; erode slowly under 2-in. (50.8-mm) or 7-in. (180-mm) head
ND2 and ND1	Non-Dispersive soil; no colloidal erosion under 15-in (380-mm) or 40-in (1020-mm)

2. SCS Chemical test (Soluble Salts in Pore Water)

The function of this test is establishing the amount of calcium magnesium, sodium and potassium cations in the pore water extract.This test was carried out following the same procedures used by the SCS of the U.S Department of Agriculture. To differentiate between dispersive and non- dispersive clays see Fig. (4).

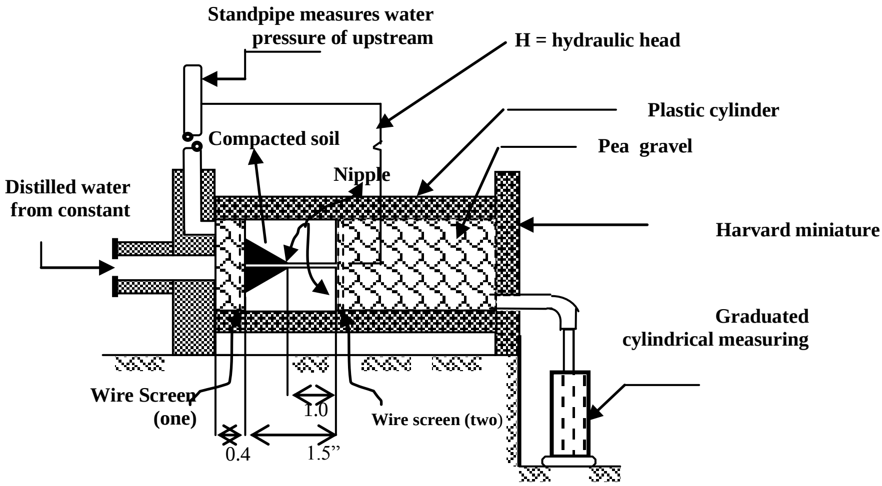


Fig.(3) Pinhole test apparatus

3. Double hydrometer test

The Soil Conservation Service had established the double hydrometer test to know the dispersive and non-dispersive clays. The test establishes the ratio between the <0.005 mm particle content measured by standard hydrometer test and that measured in a suspension prepared without dispersing agent and mechanical agitation. This dispersability index (I.D) is classified as following:

I.D <34	***The soil in non-dispersive***
I.D >68	***The soil is highly dispersive***
34< I.D > 66	***The soil is intermediate***

4. Crumb test

This test measures the diflocculation of a small air dried soil crumb submerged in distilled water. If the soil is dispersed, a colloidal cloud develops around the periphery of the crumb. Sherard [6] developed a dispersability rating system ranging between 1 and 4 for the test. Grade 1 is designating non-dispersive soil and grade 4 refers to a severely dispersive soil. The rang between grade 2 and 3 are intermediate soils.

4. APPLYING THE DISPERSIVE TESTS ON THE SAMPLES

The Pinhole test is carried out for each representative specimen from damaged area and the results are shown in Figs. (5,6). For each site, the quantity of flow under 50 mm head is very low and the exit water was very clear without any cloudiness. This means that the soil is non-dispersive soil according to Sherard classification chart. The soil can be classified as non-dispersive soil, ND4.

The chemical test also has been applied on the pore water extract of the samples to know the sodium, calcium, potassium and magnesium percentage in mleq/litre. For each sample the sodium percentage (S.P) is plotted against the total dissolved salts (TDS) in mileq/liter. The results of this test are shown in Fig. (7).

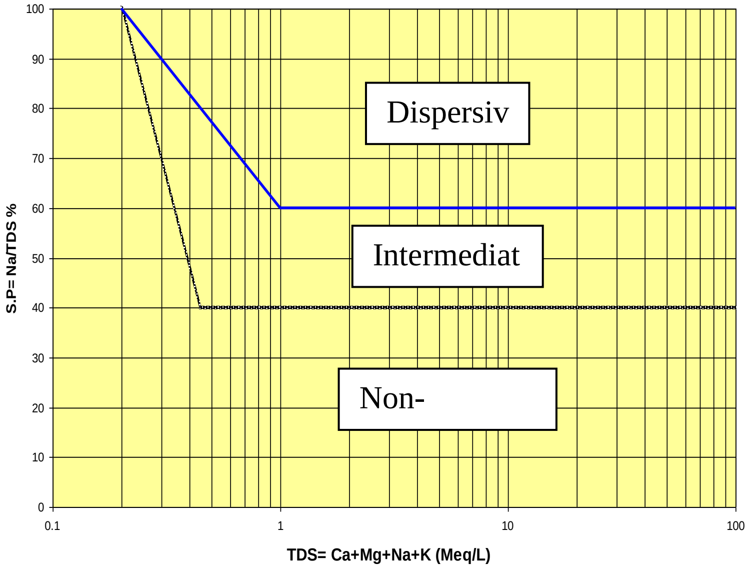


Fig (4) Chemical test results classification

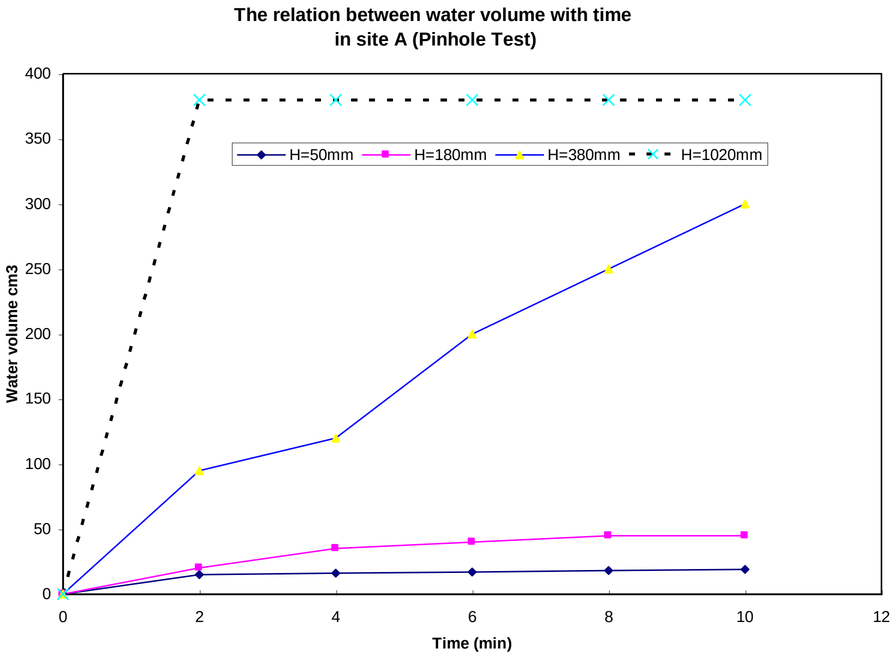
The double hydrometer dispersive test is applied on each sample and the results are summarized in Table (3). The crumb test also is used for each sample and the results are summarized in Table (4).

Table (3) Results of applying double hydrometer test.

Site	Samples	Index of dispersion I.D%	Results
A	1	22	Non-dispersive
	2	30	Non-dispersive
	3	28	Non-dispersive
B	1	35	Intermediate
	2	26	Non-dispersive
	3	34	Non-dispersive
C	1	20	Non-dispersive
	2	25	Non-dispersive
	3	18	Non-dispersive

Table (4) Results of applying the crumb test

Site	Samples	Results of the Crumb test
A	1	Grade1.Non-dispersive
	2	Grade1.Non-dispersive
	3	Grade1.Non-dispersive
B	1	Grade1.Non-dispersive
	2	Grade1.Non-dispersive
	3	Grade1.Non-dispersive
C	1	Grade1.Non-dispersive
	2	Grade1.Non-dispersive
	3	Grade1.Non-dispersive



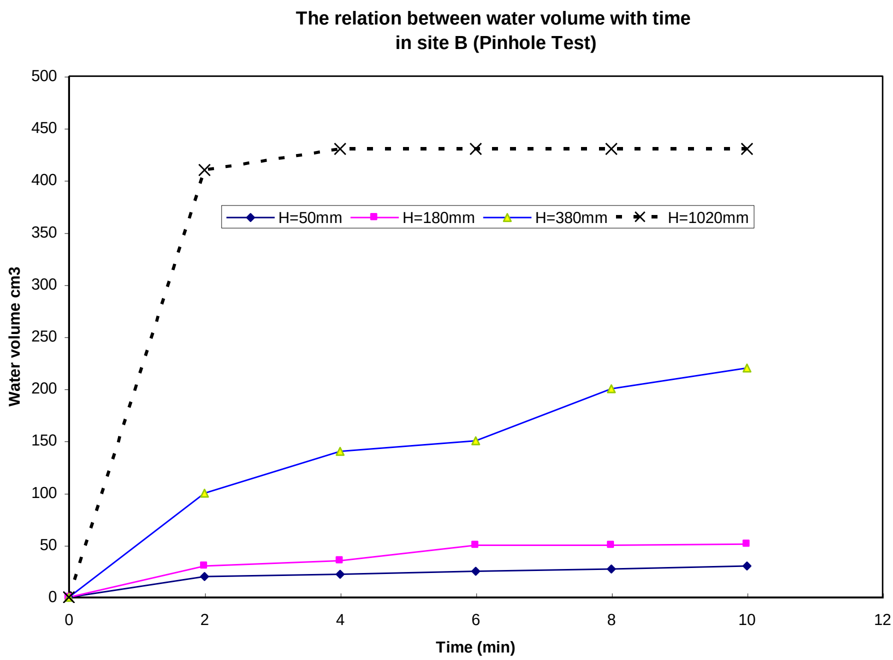
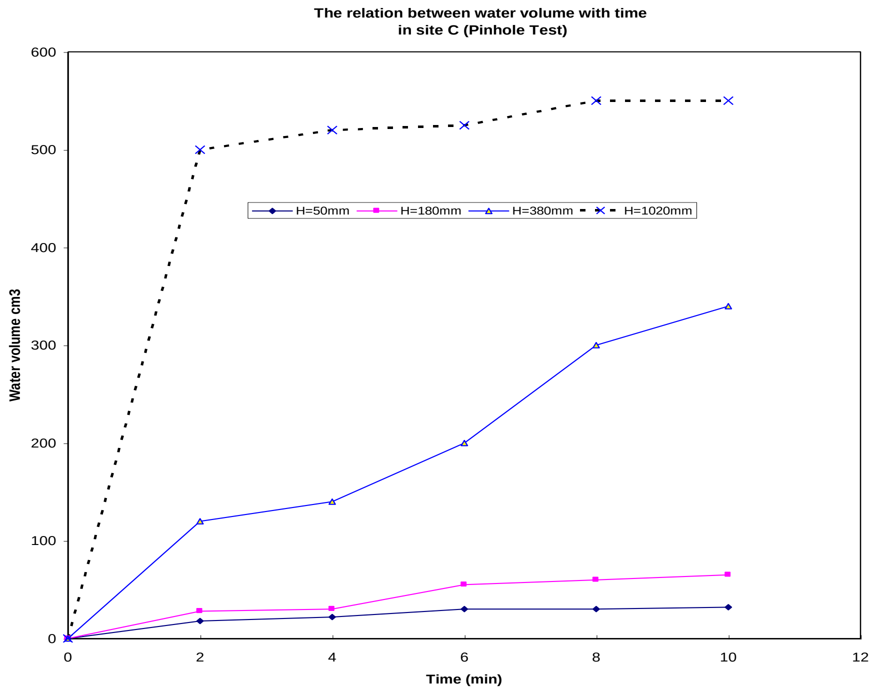


Fig (5) Pinhole Results for Soil A and B



Fig(6) Pinhole test results for soil C

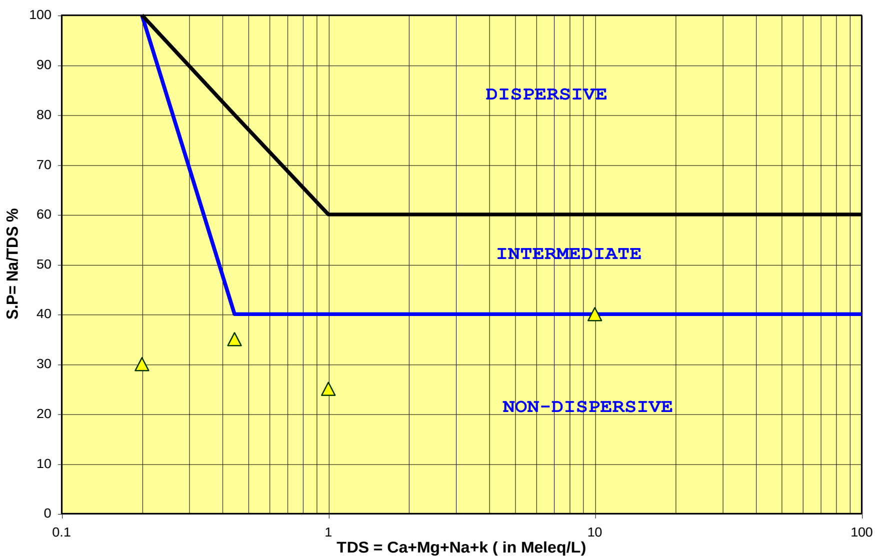


Fig (7) Chemical test results for all soils

5. RESULTS AND DISSCUSSIONS

From the pinhole tests, approximately for all samples, the discharge seeped from the test apparatus is very clear and there was no cloudiness. No colloidal erosion occurred under 15 in (380 mm) or 40-in (1020 mm). For the soil from site A, B and C, the maximum discharge was 0.63 - 0.72 and 0.92 cm^3/s respectively. These discharges are very low and clear. This leads to the fact that this soil is non-dispersive.

Also from the analyses, the S.P ratios in the pore water extract lies in the non-dispersive zone in the SCS chart. From the analyses of the results of the double hydrometer test, the max I.D equal to approximately 34 or less. This means that the soil is non-dispersive. The result recorded from the crumb test is grade 1 which means that the soil is non-dispersive soil.

6. CONCLUSIONS

The scour in the River Nile embankment represents a serious subject and may cause many dangerous effects in the river banks. From the present analyses, the following are concluded:

1- From the results of the applying the dispersion tests on the soil, it is obvious that in these sites there is no dispersive clay.
2- The dispersive clay is not responsible of the scour activity which exists in these regions.
3- This study found that there is no effect of the dispersive clay in the erosion or scouring process of the river banks. So the responsibility of this action of scour, is coming perhaps from the following factores:
   I) The water velocity.
   II) River banks direction with respect to the water flow, height, and slope.
   III) Existence of the silty soils.
   IV) Water discharge of sediments.
   V) Flood seasons flocculation.
4- It is advised to investigate the other factors that affect the scour phenomena in some areas around the Rive Nile.

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دراسة وجود الطين المتفتت في بعض مناطق النحر في أسيوط

توجد كثير من الأماكن علي جانبي مجري نهر النيل متأثرة بظاهرة النحر. هذا النحر يعتبر ظاهرة خطيرة علي النهر نفسه و أيضا علي المباني و الأماكن السياحية؛ بسبب تآكل التربة. هذا التآكل أو النحر له أسباب عدة منها ما يكون بسبب الماء وتيارات الماء و منها بسبب التربة وأنواعها وخواصها. أيضا يمكن أن يكون التداخل بين التربة و الماء هو السبب. في هذه الدراسة تم التركيز علي نوع من التربة يسمي التربة المتفتتة وهل لها وجود في بعض أماكن النحر أم لا. هذا النوع من التربة عند دخول الماء فيه فان الماء يحمل الحبيبات الدقيقة معه شيئا فشيئا حتى تتآكل التربة تماما و تتجرف مع المياه.وقد تبين من الدراسة أن هذا النوع من الطين لا وجود له في الأماكن المدروسة و يبقي أن هناك عوامل أخري كثيرة هي السبب في هذا النحر.