MODIFYING THE CLAY BEHAVIOR FOR USING IN THE CUT OFF WALL IN EARTH DAMS

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Abstract- The water leak controlling in different water structures, for example in the foundation of the dams or underground constructions, is an important fact. Some very usual and important ways of sealing in the foundation, is to construct flexible **cut** off walls made of plastic concrete. For weakening the water flow in the walls, it is common to use Bentonite and in the cases which the wall's resistance is weak, it is mostly common to add some cement to the mixture of soil and Bentonite. Usually, plastic concrete's water-cement ratio is high. In this work, the effort is to use walls, made of some additives like Bentonite and cement added to clay, instead of sealing walls and to define the mixing ratio of each. There, in this paper, has been presented 20 samples of different mixing percentage of cement and Bentonite with a fixed water-cement ratio (W/C) of two times more to the same and then it has not limited it just to push-resistance experiments, but also there it has been used permeability experiments with decreasing load.

Keywords- Plastic Concrete, Permeability, Clay, Uniaxial pressure test, Cement, Bentonite.

I. INTRODUCTION

Cut off walls, are some of the kind, which are used to control the water leak in the water flow; constructed in underground. These walls are made of substances like Flowing mud, Plastic concrete, Solid concrete and etc.; according to the type of soil. Plastic concrete is a low-resistant material (very low resistant comparing to ordinary concrete) and a high-plasticity one, compared as the same. Usually, low water-cement ratio mixtures are used in plastic concretes. This type of concrete has high plasticity and low permeability; as well it has a very high shear resistance; according to this, at this end, the target appears as well to use this type of concrete in subsidence places, loose grounds and saturated grounds, in granulated soil, and in repairing the clay-core dams, instead of the other ways like Injection. In some other projects, other substance ratios are equally used to reach higher economic benefits.

1 Material Specifications

In this research, type and specifications of the materials are presented below:

2-1 Consumed type of soil:

The soil, which is consumed in this test, is red-brown color, and it contains 14% humidity and it is mostly dense hunks.

- **XRD test:**

XRD test results is as the Table-1

Table-1: XRD test results

Na2O	0.06%
K2O	0.64%
MgO	9.16%
SiO2	27.72%
CaO	26.76%
Fe2O3	3.31%
LSF	27.26%
SiM	2.24%
AlM	2.85%

- **Soil gradation:**

The curve of particle size distribution for this type of soil is granted in Fig-1.

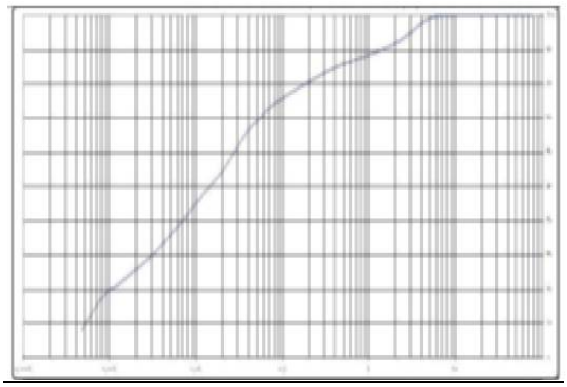


Fig-1: The curve of particle size distribution

- Liquid Limit:

In this test, we intend to define the humidity percentage of the soil, in case of flow, by considering ASTMLD516 standards. The Liquid Limit, used in this experiment is equal to 35 (Considering the soil, passed out from No.40). Back to the intention, the target is to define a type of soil, which in plasticity form, cracks less than the other types. The test is monitored by ASTM: D42761 standards as well. The

plastic limit used in this article, is equal to 14 (as well as density, considered sifter No.40).

2-2 Cement:

Hydraulic-Binder is a material, which is made of some kind of mineral powder, mixed with water and it becomes very hard by the time. In the Plastic Concrete, cement is worked as the binder to keep the mechanical resistance high. Cement, keeps a high pressure resistance and a high authorized hydraulic gradient in soil as well. In other words, cement makes the concrete more resistant against the leaching of the soil caused by water infiltration. In the mixing profile, with a higher percentage of cement, there comes a lower plasticity, in addition to higher components transplantation permeability. In this article, we have used type-2 cement of Sofian city to make the mixtures of cement and soil.

2-3 Bentonite:

Bentonite causes an internal separation in the components of the plastic concrete; as result, the separated parts, observe more water; in addition, the mixture becomes more identical, and will operate better. If we consider, the consumed Bentonite, covers a plasticity of 40 to 70 under standards of ASTM[424-59(1971)], in this case, it would be more alike a clay, which observes water, 5 times more than its own weight and is inflated 10 to 13 times more compare to its dry form.

2-4 The amount of used water:

Considering the facts, like ordinary concrete, the water must be pure, with no harmful chemical combinations like Sulfates, Carbonates, and Chlorides, and it needs to be neutral. Mostly, the water of rivers and pits are very suitable for this end. In this article, the consumed water is the drinking water of Tabriz, Iran.

2-5 Preparing the samples:

- **Preparing the consumed soil for production of the samples:**

To begin, we dry the soil in normal, outdoor weather and then in the second step, we harvest the soil sample for all tests, after chopping them and letting them to pass the sifter No.10. This will appear more logical when we have the results. It must be considered that clay needs some especial treatments by the process of drying, in order to make sure that it will not turn into hunks.

- **Mixture operations:**

First of all, we pour the Bentonite into the blender, and then add water, and we wait 5 minutes until the whole cement is completely mixed and is fixed. In the next step, we add cement and soil into the mixed bentonite, and again we wait 5 minutes until the blending operation is finished. It must be considered that the blender must work on low speed, and the soil and cement must be added slowly to the bentonite, so that, the final mixture will produced with no hunks.

- **The percentage of incorporation:**

The mixtures used in this article for Uniaxial pressure test and permeability test, are considered with water-cement ratio (W/C) of 2. The weight ratio of cement to soil is considered as 8% and 10% and 12% and 14% and 16% which the fixed cement amount is denoted as 2% and 3% and 4% and 5%. Bentonite is added to the dry soil as it is demanded; meaning in consequence, there, we've produced 20 types of samples, which are shown in the Table-2.

Table-2: The mixtures plan

Cement percentage	Bentonite Percentage			
8	2	3	4	5
10	2	3	4	5
12	2	3	4	5
14	2	3	4	5
16	2	3	4	5

- **Production of the samples:**

In order to the samples to be more identical, we have used an especial mallet and template instead of ordinary standard proctor ones, so that there we have samples from 48mm to 100mm for the test of Uniaxial pressure test and permeability. For making these samples, we have used an especial compressor machine, which has template aspects, similar to the uniaxial pressure test aspects. The results obtained from special mallet and template, are similar to the proctor test as well. For better reach to the sample, first we put a rubber ring inside the template and then pour the mixture in the template, in 3 different layers.

The mallet has 1247grams weight and it falls down from a height of 15.24 centimeters. After each layer is made, we compress the mixture of soil and lime, with 22 strokes of mallet each time. The compression process must take place in in 1 minute, which there must all the 22 strikes fit in. This must be done for all the 3 layers, and then it must be flattened and kept for rest.

- **The duration time:**

The duration time and the effective lifetime for the samples are 28 days. The humidity of all the samples must be constant during the process of production.

CONCLUSIONS AND DISCUSSION

As presented before, there was to kinds of tests we used; to measure the permeability and does the uniaxial pressure test. Here, we study the results of the uniaxial pressure test that were tested on samples

with different amounts of mixing ratio, which was presented above. These conclusions can help us to realize the best ratios of mixing the additives. As shown in the Fig-2, by putting all the results in one single diagram, we can derive a conclusion that by the higher amount of cement, not a huge uniaxial pressure resistance is seen; and defining the best amount of cement and bentonite is a very important fact to be reached out. Approximately, in all of the samples, a ratio of 12% cement shows us a good resistance in final result. In a general look, the variations of results obtained from the test of permeability and strength, in not predictable exactly and they need more tests and experiments. It means, it was expected that by increasing the amount of cement, with a constant amount of bentonite, the result should have derived us a higher amount of resistance, but the results show the opposite of this claim; telling us finding optimized ratios have higher priorities in these tests. In the next step, the consumed fact is the 'permeability' which we will discuss it below. With a look at the Fig-3, and considering a comparison to the obtained consequences from permeability tests, a fixed amount of 4% bentonite and 10% cement in the sample, gives us the minimum amount of permeability. Also, a mixture of 12% cement and 2% bentonite, gives us an optimized amount of strength obtained from the mixing profile (Consider Fig-3).

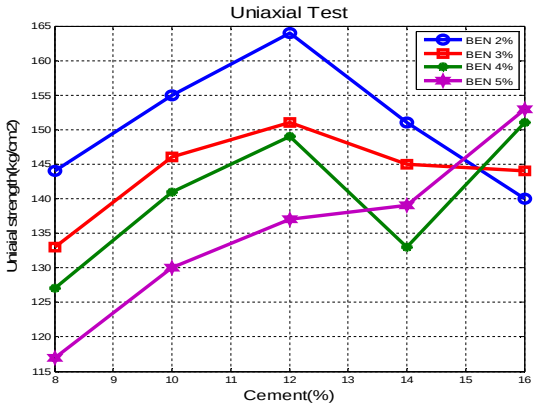


Fig-2: Uniaxial pressure strength

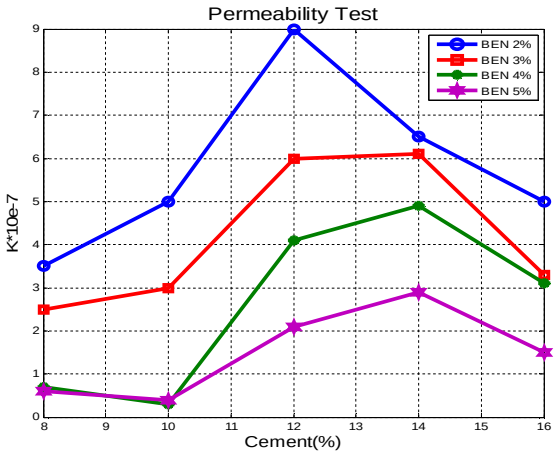


Fig-3: Permeability

Now, by considering different projects, and by holding to which test results represents more importance, we should control the test result: 'resistance of the walls or the factors of the permeability', for a logical instruction. For example, in cases that there is no prediction or knowledge about the cut off walls under pressure of lateral loads, or the external forces,
the importance of the 'resistance' is the factor of choice; or in cases which the walls are under effect of hydraulic gradients, in underground water flows, and also there is high risk of water leak, the factor of 'permeability' is the main factor to be considered.

CONCLUSIONS

- Defining a proper mixing profile is based on the measurements of the project and its place of construct. For an example, in cases which there is high risk of leak and high hydraulic gradients, the main considerable factor of construction would be the "Permeability", but in cases which there are high risks of earthquakes which are intended to be under high pressure of lateral forces, the factor of "Strength" is the proper fact for construction.

-Though by increasing the amount of bentonite in samples of the test, the amount of permeability decreases, but to reach a specified strength in this end, there would be more need to cement.

- The amount of uniaxial pressure strength is not increased properly by increasing the amount of cement. Defining the optimized ratio of cement-bentonite is important to build up a good-conditioned mixing profile.

- Considering the type of local soil and the laboratory circumstances, as mentioned above, samples of the 12% cement and 2% bentonite have the maximum amount of strength, and the sample which are mixed with percentage of 10% cement and 4% bentonite, have the minimum amount of permeability.

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