Asesorías y Tutorías para la Investigación Científica en la Educación Puig-Salabarría S.C.
José María Pino Suárez 400-2 esq a Lerdo de Tejada. Toluca, Estado de México. 7223898475
RFC: ATI120618V12

Revista Dilemas Contemporáneos: Educación, Política y Valores.
http://www.dilemascontemporaneoseducacionpoliticayvalores.com/

Año: VI **Número: Edición Especial** **Artículo no.:60** **Período: March, 2019**

TÍTULO: Efecto de la química del agua de poro en el comportamiento hidromecánico de la arcilla expansiva compactada.

AUTORES:

1. Yaser Vanda.

2. Saber Avestakh.

RESUMEN. La ciencia de los poros fluidos puede cambiar seriamente las organizaciones de mezcla de suciedades por métodos para cationes intercambiables. El punto es decidir la tasa de progreso en una parte de las propiedades de ingeniería geotécnica de los suelos arcillosos cuando se presentan a las sales con respecto al agua refinada. Así, reunimos altas arcillas expansivas del estadio deportivo en la universidad del este del Mediterráneo, al norte de Chipre. Los resultados ilustran que la concentración de la solución afecta directamente a un rango de parámetros que van desde la resistencia a la tracción por evaporación, la compresión no confinada, hasta la tensión interna que se desarrolla a contenidos de agua gravimétricos específicos.

PALABRAS CLAVES: suelos insaturados, desecación, encogimiento, química.

TITLE: Effect of pore water chemistry on hydro-mechanical behavior of compacted expansive clay.

AUTHORS:

1. Yaser Vanda.

2. Saber Avestakh.

ABSTRACT: Pore fluid science may seriously change the concoction organizations of dirts by methods for interchangeable cations. The point is to decide the rate of progress in a portion of the geotechnical engineering properties of clayey soils when presented to salts regarding refined water. Thus, we gathered high expansive clays from sport stadium in eastern Mediterranean university, north Cyprus. The results illustrate that the solution concentration straightly affects a range of parameters ranging from the evaporation tensile strength, unconfined compression to the internal stress that develops at specific gravimetric water contents.

KEY WORDS: unsaturated soils, desiccation, shrinkage, chemistry.

INTRODUCTION.

Clays are significant constituent of soils, which evolve mainly from chemical weathering of rock forming minerals, and regarded as fine grained soils in geotechnical engineering. Clays may show substantially distinctive engineering behavior principally rely on their mineralogical and chemical constitutions. Pore fluid chemistry may meaningfully modify the chemical compositions of clays by means of exchangeable cations, which rule the engineering properties of clays in most cases.

All clays have high affinity for water; yet, some clayey soils swell more than others. Swelling muds; for example, montmorillonite mineral gatherings bring difficult issues including expansive settlements under superstructures or using pressurized water penetrable on account of progress in the pore fluid qualities. Such issues predominantly emerge from adjusts in physicochemical condition of soil particles, coming about changes in the thickness of the diffuse twofold layer. Pore fluid science is one of the elements that influence the adsorbed water layer thickness encompassing the dirts. That is, solid cation focus, high cation valence and acidic condition drastically decline the twofold layer thickness around the mud particles. In this way, the execution of earth structures, for example, impermeable dirt liners alter in a sensational way when the pore fluid science of the framework changes with time. Then again, twofold layer thickness around non-swelling muds diminishes when presented to synthetics also.

There are a few investigations detailing varieties in building conduct of muds or clayey soils after testing with pore fluids other than refined water or faucet water. An itemized rundown of these examinations can be found in Bowders and Daniel (1987), Sridharan et al (1991), Kaya and Fang (2000) and Ören and Kaya (2003). These investigations detailed that inorganic salt arrangements strongly affect the building conduct of muds, particularly on swelling muds. Nonetheless, the impacts of saline waters on the compressibility and additionally swelling conduct of soils are not known well. The impacts of saline waters on the building conduct of soils should be resolved since the saltiness of pore fluid of fine grained soils close beach front regions increment constantly. Such increment is expected chiefly to bringing down the groundwater level beneath mean ocean level in beach front territories, bringing about seawater relocation towards land. For instance, revealed that some vital issues happened because of broad ground settlement upon saltiness interruption from siphoning of groundwater in the Shiroishi marsh plain, southwestern Kyushu Island of Japan. Correspondingly, the groundwater level is dropping consistently in different parts of the beach front regions of Turkey, because of over the top withdrawal for mechanical and farming purposes, causing interruption of seawater toward land. In addition, ground settlement related issues and different issues ought to likewise be normal from ocean level ascent on account of an Earth-wide temperature boost.

Basma et. al. (1996) examined on four recognize soils to finish up the impact of cyclic swell– recoil on broad soils. Both incomplete and full psychologist methodology were executed. For halfway therapist, tests were approved to dry at room temperature, and for full psychologist, tests were presented to daylight. The results of the tests demonstrated that an addition in the swell potential was checked after full therapist and a decrease was seen after partial shrink. Tawfiq and Nalbantoğlu, (2009), considered the impact of the cyclic wetting and drying on the swelling conduct of a characteristic far reaching soil with fluid limit and plasiticity record estimations of 64% and 36%, separately. Outcomes of the tests showed that swell potential raised after full swell-full therapist cycles and decreased after full swell-fractional shrink cycles.In addition to these researchers, the studies of (Popesco, 1980; Osipov et al. 1987) on nonstabilized soils illustrated that full swell-full shrink cycles caused an increments in the swelling potential of soils, in addition the studies of (Chen & Ng, 2013) indicated that reduction occurred in swelling potential of expansive soils that exposed to full swell-partial shrink cycles (Basma et al, 1996; Liua et al., 2016).

Most surficial soils are subjected to wetting–drying cycles because of alternative precipitation and evapotranspiration. The wetting–drying cycles can meaningfully affect the hydro-mechanical conduct of unsaturated soils. An important number of studies (Cui and Delage, 1996; Lloret Morancho et al., 2003; Zhan and Ng, 2006) have been conducted on the impact of water content on the hydro-mechanical treatment of unsaturated soils. Lately, the role of wetting–drying cycles in the hydromechanical behavior of unsaturated soils has received special consideration (Gens et al., 2006). In most of the soils isothermal drying can be adopted if the phase alteration rate is restricted by the mass transfer, and not regulated by the heat exchange (Peron et al, 2009).

Matric suction of soil increases with increasing crack volume, both for evaporation and infiltration conditions (Fredlund & Morgenstern, 1976). This author (Alamdar-Niemann et al, 1991; Mahasneh, 2004; Yukselen-Aksoy et al., 2008; Mansour et al. 2008; Arasan & Yetimoglu, 2008; Shariatmadari, et al. 2011), have studied the impact of salt solutions on the consistency limits of soil. The results have demonstration the liquid limit and plastic limit of soil decline as the salinity of pore fluid increments.

Park et al. (2006) considered the impacts of surfactants (octylphenol polyoxyethylene, biosurfactant, and sodium dodecyl sulfate) and electrolyte arrangements (NaPO3 and CaCl2) on a few properties of two soil tests (100% kaolinite mud soil, and 30% kaolinite + 70% sand). They found that compound arrangements did not essentially influence the water powered conductivity. It was shown that the pressure driven conductivity diminished when the grouping of the salt arrangement was expanded for CL muds.

Some exploratory tests on kaolinite mud demonstrated that water driven conductivity diminished when earth tests were saturated with substance arrangements; for example, CH3)2CO, benzene, diethylene glycol, nitrobenzene, phenol (Dragun, 1988). Rao and Mathew (1995), in light of their trial examine with marine earth, showed that the decrease in water driven conductivity was identified with the scattering and deflocculation of mud. Additionally, Park et al. (2006), in the wake of leading a trial contemplate on low versatility kaolinite dirt, revealed that the water powered conductivity was not altogether influenced, but rather somewhat diminished because of pore obstructing and the high thickness of the arrangements.

Petrov et al. (1997) established that for ethanol focuses under half, the pressure driven conductivity of the GCL diminished because of the expansion in thickness. Consequently, the decline in pressure driven conductivity could be credited to scattering of the dirt particles when CL earth was penetrated with inorganic salts. It could be additionally said that the decline in water driven conductivity is because of development of new swelling sort of mixes also (Sivapullaiah & Manju, 2006).

The aim of this investigation is to decide the rate of progress in a portion of the geotechnical engineering properties of clayey soils when presented to salts regarding distilled water. Thus, we gathered high expansive clays from sport stadium in eastern meditereanian university, north Cyprus.

DEVELOPMENT.

Materials and methods.

Physical properties.

Liquid Limit.

The liquid limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. The moisture content at this boundary is arbitrarily specified as the water content at which two halves of a soil cake will flow together, for a distance of ½ in. (12.7mm) along the bottom of a groove of standard dimensions separating the two halves, when the cup of a standard liquid limit apparatus is dropped 25 times from a height of 0.3937 in. (10 mm) at the rate of two drops/second.

Plastic Limit.

The plastic furthest reaches of a dirt is the dampness content, communicated as a level of the heaviness of the stove dry soil, at the limit between the plastic and semisolid conditions of consistency. It is the dampness content at which a dirt will simply start to disintegrate when folded into a string ⅛ in. (3mm) in measurement utilizing a ground glass plate or other satisfactory surface.

Plasticity Index.

The pliancy index of a dirt is the numerical distinction between its fluid limit and its plastic limit, and is a dimensionless number. Both the fluid and plastic cutoff points are dampness substance.

Plasticity Index = Liquid Limit - Plastic Limit

PI= LL- PL

PI= 61- 30= 31

Grain Size Distribution (Hydrometry).

The level of sand, sediment and dirt in the inorganic part of soil is estimated in this methodology. The technique depends on Stoke's law administering the rate of sedimentation of particles suspended in water. The example is treated with sodium hexametaphosphate to complex Ca++, Al3+, Fe3+, and different cations that quandary mud and residue particles into totals. Natural issue is suspended in this arrangement. Rectifications are made for the thickness and temperature of the scattering arrangement.

Specific Gravity.

This lab is performed to decide the specific gravity of soil by utilizing a pycnometer. Explicit gravity is the proportion of the mass of unit volume of soil at an expressed temperature to the mass of a similar volume of without gas refined water at an expressed temperature. The specific gravity of a dirt is utilized in the stage relationship of air, water, and solids in a given volume of the dirt.

$$\text{Specific Gravity}, G_S = \frac{W_0}{W_0 + (W_A - W_B)}$$

Our soil specific gravity: 2.62

Consolidation.

This test is performed to decide the greatness and rate of volume decline that an along the side kept soil example experiences when exposed to various vertical weights. From the deliberate information, the combination bend (weight void proportion relationship) can be plotted. This information is helpful in deciding the pressure list, the recompression record and the preconsolidation weight (or greatest past weight) of the soi. Moreover, the information acquired can likewise be utilized to decide the coefficient of solidification and the coefficient of optional pressure of the dirt.

ASTM D 2435 - Standard Test Method for One-Dimensional Consolidation Properties of Soils.

The combination properties decided from the union test are utilized to gauge the size and the rate of both essential and optional union settlement of a structure or an earthfill. Assessments of this sort are of key significance in the plan of built structures and the assessment of their execution.

Linear shrinkage.

This test covers the assurance of the direct shrinkage of a bothered soil test. It is a monotonous and costly test that is done just on soils (other than sands) when the scattering rate is >50 or volume development tests neglect to immerse or recoil. This test is performed on dispersive soils as it were. Direct shrinkage is the decline long of a dirt example when broiler dried, beginning with a dampness substance of the example at as far as possible.

$$LS\ (\%) = \frac{L_S}{L}\ x\ 100$$

Where:

L = Length of the mould (mm)

L_S = Longitudinal shrinkage of the specimen (mm)

No particular data on the exactness of the test is accessible. Be that as it may, with experienced administrators just a single assurance is essential for each dirt example. It is commonly ideal, for soil characterization, to lead the test on various examples instead of copy judgments of the one example.

Volumetric shrinkage.

Following seven days of swelling tests were prepared for volumetric shrinkage, when we put out the examples from oedometer weight them place them in the 40 level of centigrade broiler and measure tallness and width of test in 1 hour interims, we likewise weight them, following 48 hour we should place tests in 60 degree stove for 24 hours and after that measure Ms.

Unconfined compression test.

ASTM D 2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.

No exceptional cutting is required when examples got with the California sampler are utilized in this test. Expel the dirt from the 101.6 mm high example retainer in which it is gotten by pushing it same way it entered the cylinder, and afterward put, test specifically into position on the stacking gadget. Trim soil which is gotten in a Shelby tube or a square example to a 38.1 mm x 38.1 mm x.

For soils, the undrained shear strength (su) is necessary for the determination of the bearing capacity of foundations, dams, etc. The undrained shear strength (su) of clays is commonly determined from an unconfined compression test. The undrained shear strength (su) of a cohesive soil is equal to one-half the unconfined compressive strength (qu) when the soil is under the f = 0 condition (f = the angle of internal friction). The most critical condition for the soil usually occurs immediately after construction, which represents undrained conditions, when the undrained shear strength is basically equal to the cohesion (c). This is expressed as:

su = c = qu/2

Then, as time passes, the pore water in the soil slowly dissipates, and the intergranular stress increases, so that the drained shear strength (s), given by s = c+ s'tan f, must be used. Where s'= intergranular pressure acting perpendicular to the shear plane; and s'= (s - u), s = total pressure, and u = pore water pressure; c' and j' are drained shear strength parameters.

Unconfined Penetration Test.

After every example was readied, its weight was estimated to compute the unit weight. Qualities of Soil Samples and base in the stacking pivot. The example was then put on the base plate and was agreed with the circles (Fig. 2). This arrangement between two plates and the dirt example is essential. At that point, the base plate was raised by moving the hub of the stacking arm until the base surface of the example was in contact with the base circle. A heap was relentlessly connected at the chosen rate (2%= min, 1%= min, 0:5%= min, or 0:1%= min). The power was connected until the point that disappointment happened in the example. The power and uprooting amid testing were recorded through the information lumberjack. The pinnacle stack was utilized for computing the elasticity of the blended soil example by Eq. After the test, the cracked example was gathered rapidly and weighed both when broiler drying to decide its water content.

$$\sigma_t = \frac{P_{\max}}{\pi(MbH - a^2)}$$

where $M = \tan(2\alpha + \phi)$.

Filter paper.

The arrangement strategy of tests is the equivalent for every one of the tests: Place soil in compartment include ideal water content smaller it with hand, include more water content for immersion, fixed them to anticipate dissipation. The test methodology includes putting a bit of at first air dry channel paper against the compacted soil example whose matric suction is required and fixing the entire to avoid dissipation. The channel paper at that point wets up to a water content in balance with the greatness of the dirt matric suction, and watchful estimation of the water substance of the channel paper empowers the dirt matric suction to be gotten from a recently settled relationship. This gives a proportion of the matric suction, which is thought to be the equivalent numerically as the capillary pressure (the reference being the atmospheric pressure). The Whatman 42 channel paper was utilized in all tests.

Tanks.

We want to simulate natural condition in laboratory, so we put a huge amount of soil and water leave it to saturate then subjected to sun light. It takes approximately 1 month to be saturated. We should take photo before and after desiccation to determine crack intensity factor (CIF) with Photoshop software.

Crack Intensity Factor (CIF).

The split force factor (CIF) was presented as a descriptor of the degree of surficial breaking. CIF is defined as the proportion of region of splits (A) to the all-out surface territory (An) of c t a drying soil mass. A PC helped picture examination program was utilized to decide the CIF esteems. The zones were resolved utilizing photos of parching soils. Splits seem darker than remaining uncracked soil surface in photos of a drying soil. The difference between the shade of the breaks and the uncracked soil is utilized to ascertain the CIF.

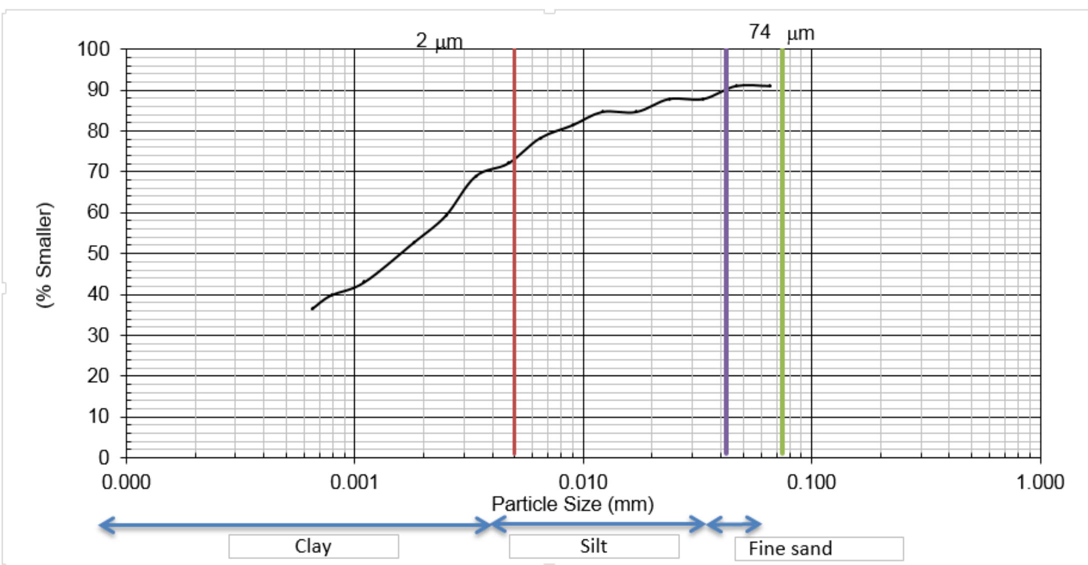
After we took photography a calibration of image-pixel size was performed as follows: (1) Using the magnetic lasso tool in Adobe Photoshop, the inside perimeter of the outer confining ring was traced and saved as a new layer, (2) for consistency, the selection's color threshold level was set to 128 (in 256 color-mode) so that the selection file can only have pixel values of 0 or 1 and (3) by knowing the diameter of the ring (R), the image pixel area (A PIXEL) was obtained by dividing the total internal area of the specimen by the total number of white pixels.

CIF= (surface area of cracks) / (total surface area of soil).

Results and Discussion.

In Fig 1, you can see our soil results for grain size distribution (hydrometery), our soil has 70% clay, 20% silt and also 10% sand.

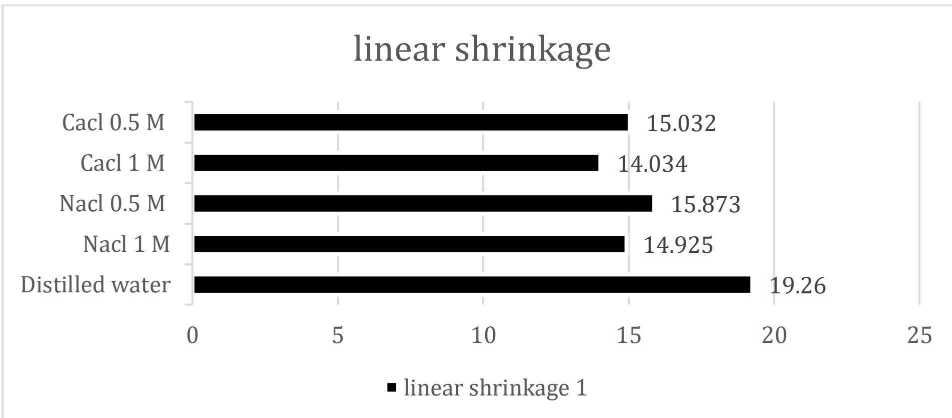
Fig 1.



Specific gravity (Gs) of the soil that we work on it is 2.62 and it can calculate from average of some parallel tests which we performed together. Optimum water content can be defined from compaction tests and for our soil it was 25%, other parameter that we can determine from compaction test is dry density of soil and this number for our soil is 1.451.

The other test which carried out on our soil was linear shrinkage and you can see in these two-pie chart that salinity can reduce the shrinkage. For both salts and also both Mols what we used we can see near results in Fig 2.

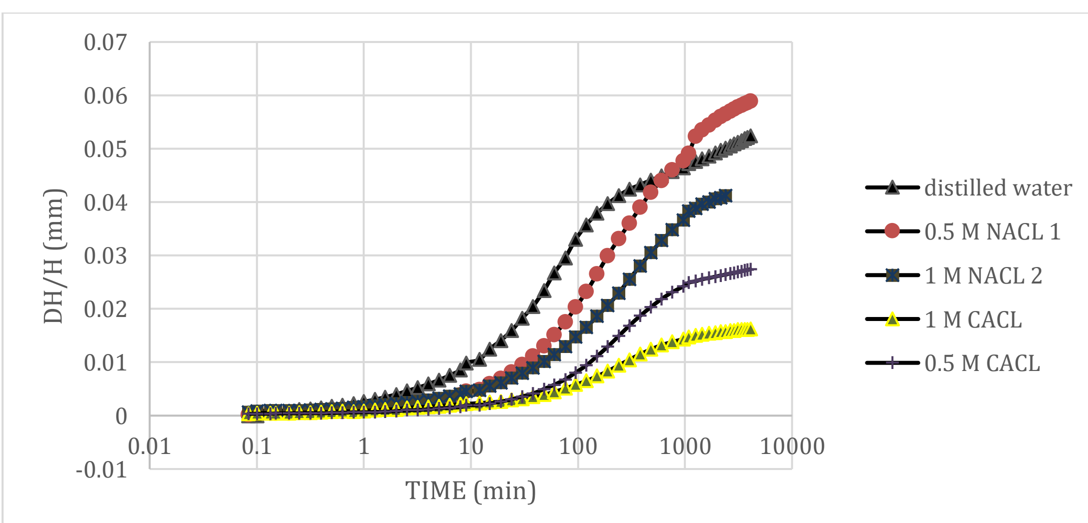
Fig. 2



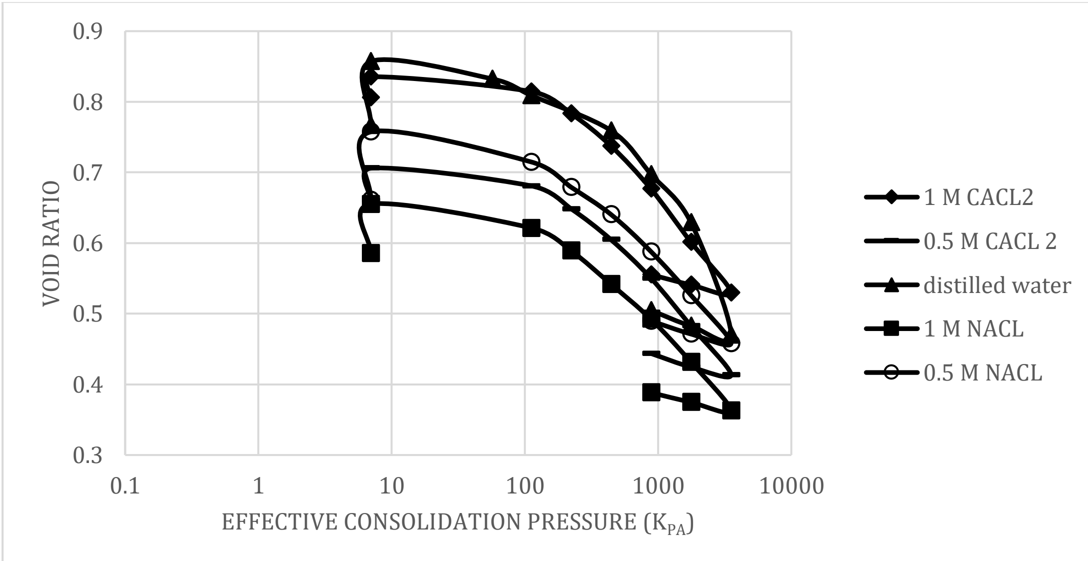
One dimensional consolidation.

Salt can reduce the swelling, in this treatment Cacl2 is more effective than NaCl, and you can see results in Fig 3. these effects are due to effect of salt on suppressing the diffuse double layer, these effects can decrease shrinkage also.

Fig. 3

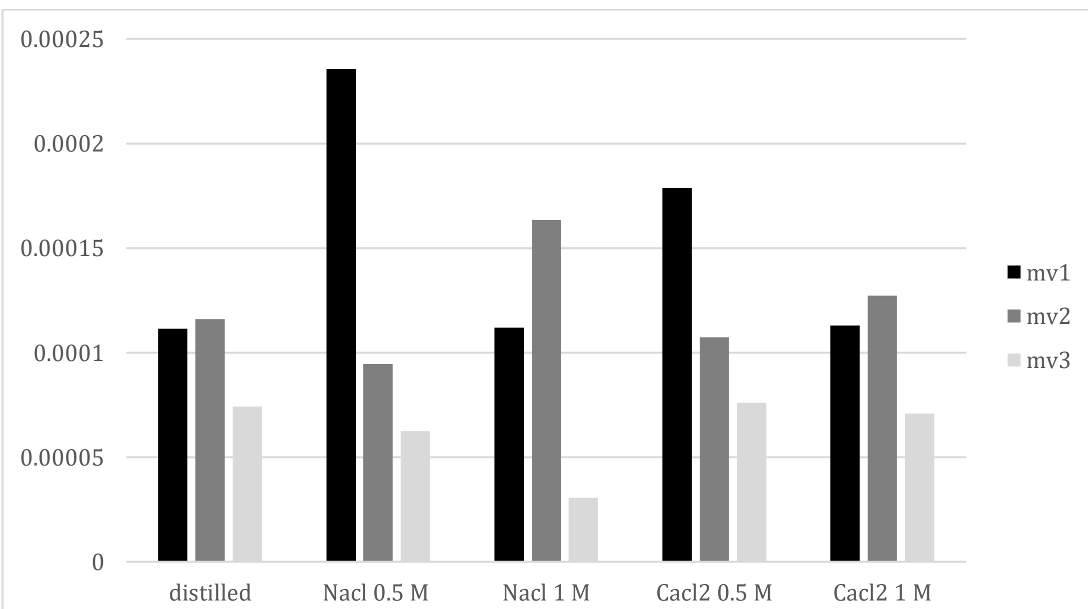


In Fig 4, you can see consolidation curve and parameters, in our tests salt decrease consolidation parameters and effect of Nacl is more than Cacl2.



Other parameter, that we can measure from consolidation curve, is hydraulic conductivity; it seems that Nacl increase hydraulic conductivity but on the other hand Cacl2 does not have that much effect on this parameter, you can see the results in figure 5.

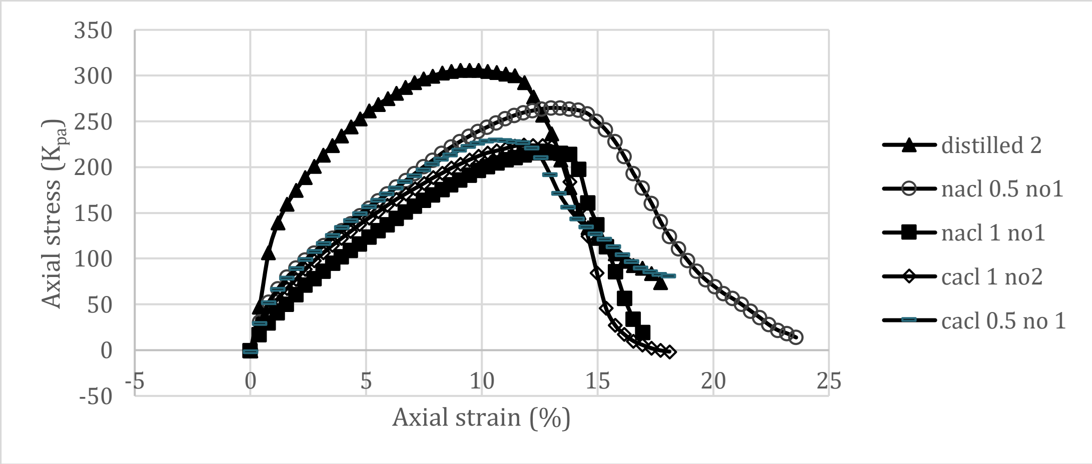
Fig. 5



Unconfined compression.

Another test we performed on our clay was unconfined compression and with increasing the M of salts it can be reduce and soil collapse earlier than distilled water, you can see the results in fig 6.

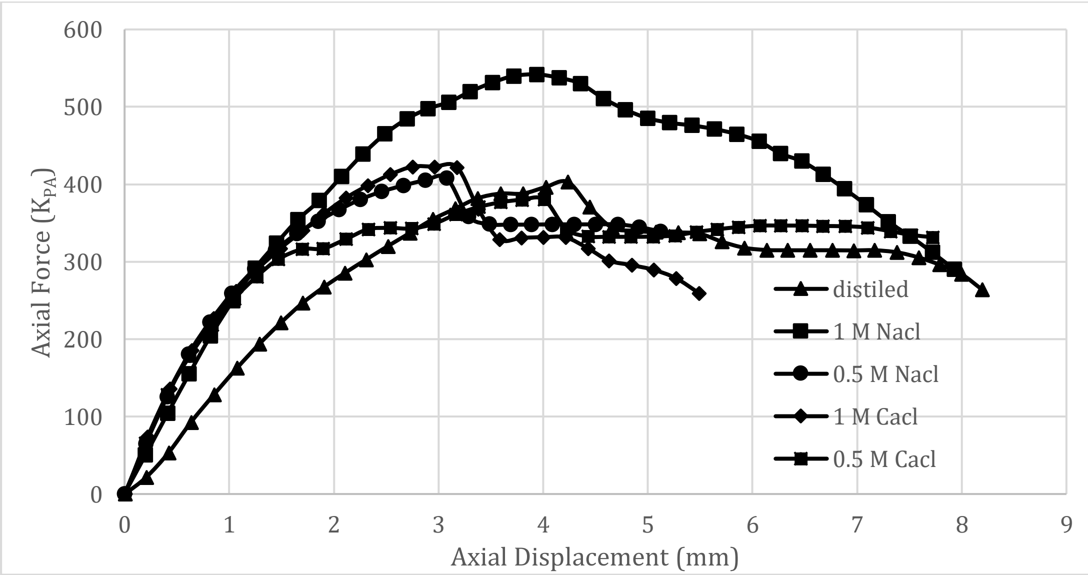
Fig. 6



Tensile strength.

Tensile strength is another test that we performed on our soil with different M of salt solutions and results show us salt solutions can increase strength of soil particularly Nacl in this parameter it has more effect. Fig 7 display results of this experiment.

Fig. 7



We also calculate σt and results is showing in table 1. This table give us information about maximum tension that our soil can bear and it illustrates 1 M NaCl has the highest effect.results are shown in table 1.

Table 1.

Sample	Distilled water	1 M NaCl	0.5 M NaCl	1 M CaCl2	0.5 M CaCl2
σt	2.33	3.13	2.94	2.44	2.202

Cyclic swelling and shrinking.

I did cyclic swelling and shrinking and in swelling part I define that in second cycle huge increase occurred but in third and fourth cycle it can increase but not too much. In shrinking part every cycle can reduce shrinkage nothing special happen. Fig 8, 9 show us results.

Fig. 8

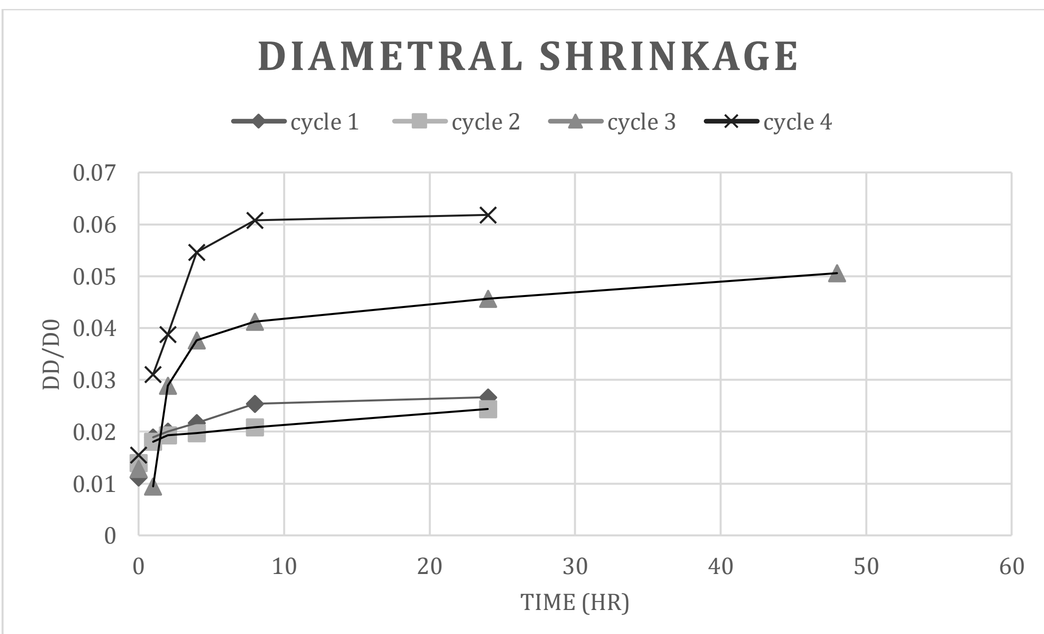
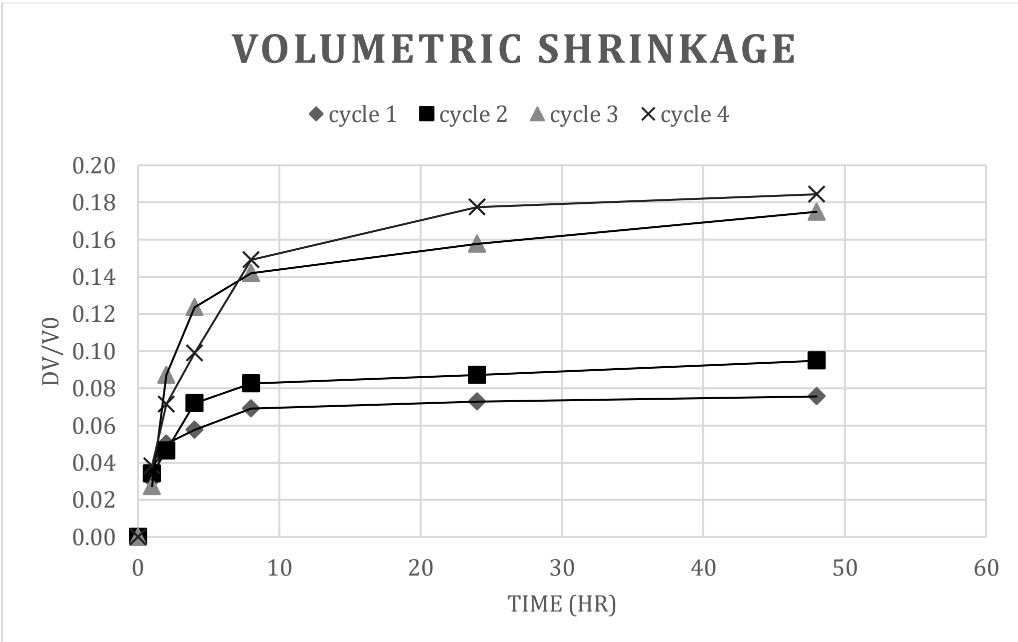


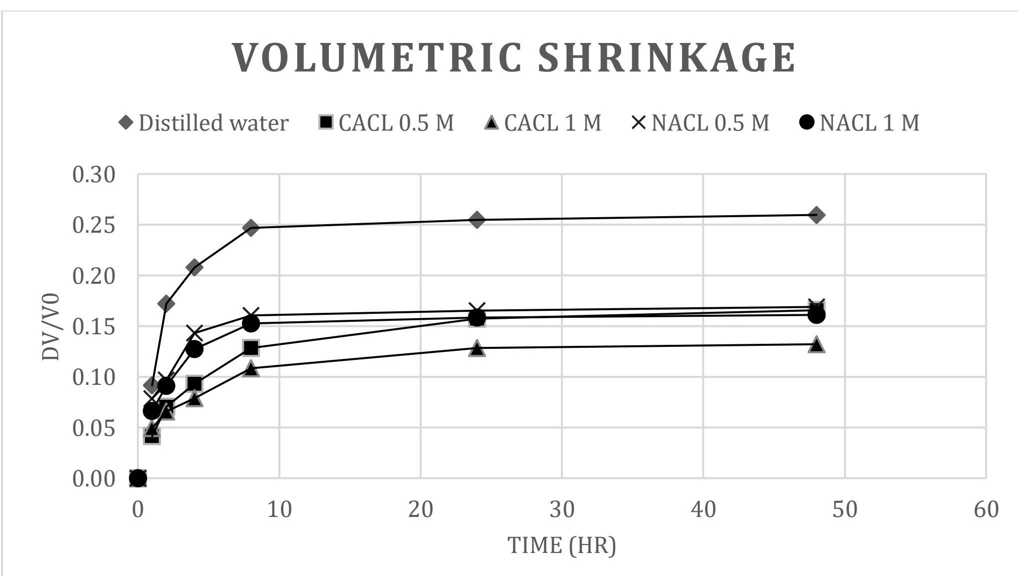
Fig 9



Volumetric shrinkage.

We also carried out volumetric shrinkage with different M and we defined that salt can reduce shrinkage, you can see results in Fig 10. Higher M lower shrinkage, in addition CaCl2 has highest effect on shrinkage.

Fig. 10



Soil vision.

After we finished all works, we put suction and shrinkage on soil vision program and also fit our results with other researchers, extract graphs and tables, in the following you can see the results, salts can reduce air entry value and also rate of shrinkage but on the other hand they increase the suction. you can see results in fig 11 and 12.

Fig. 11

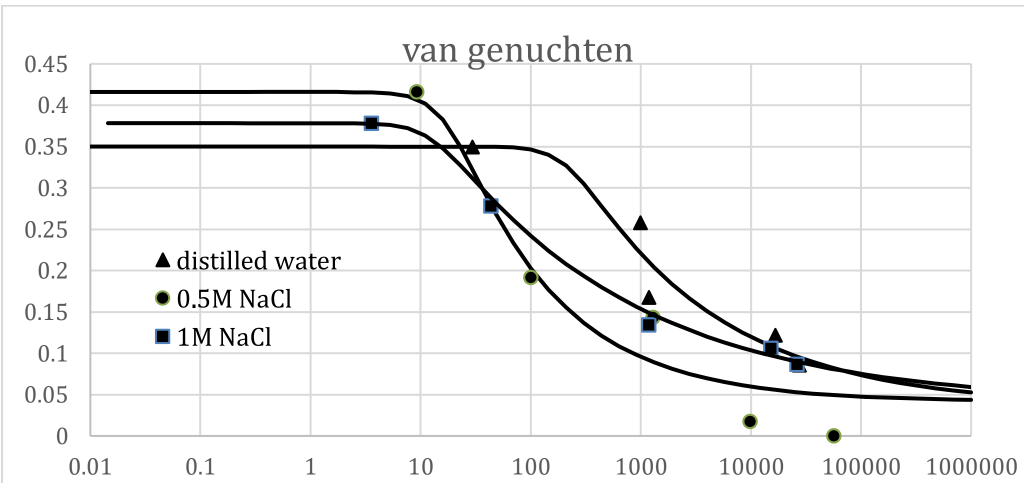
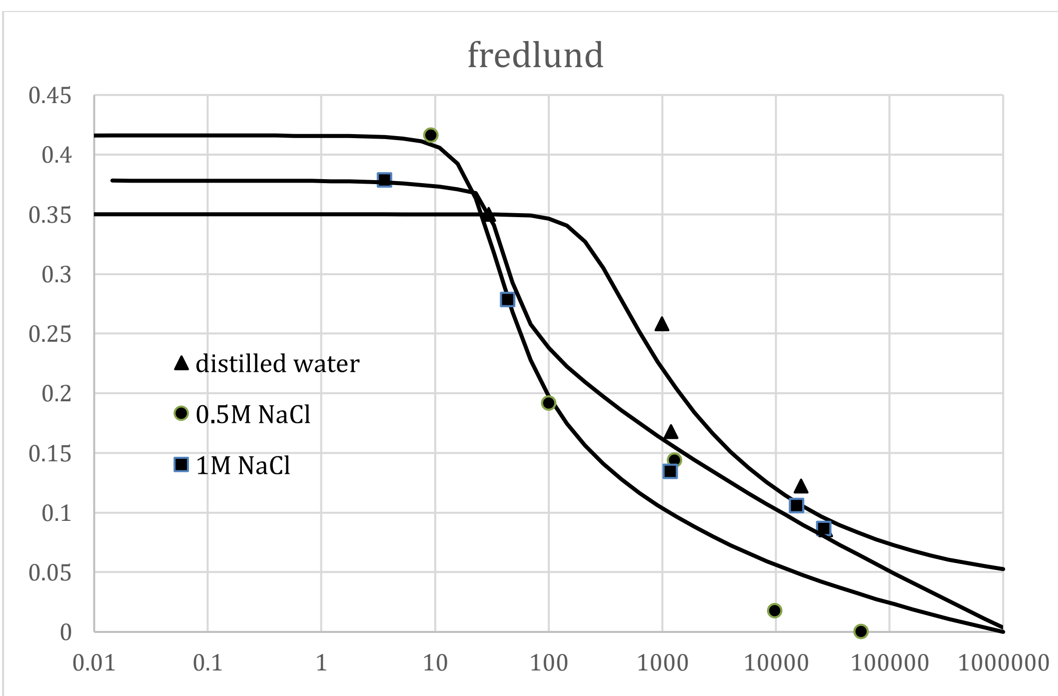


Fig 12



CONCLUSIONS.

This paper inspects the effect of pore solution properties on the hydromechanical behavior of soil systems at the laboratory scale. The consequences are clarified while explicitly taking into account the influence of the pore solution concentration and possessions on the stress/strain advanced during drying. The outcomes illustrate that the solution concentration (salinity) straightly affects a range of parameters ranging from the evaporation tensile strength, unconfined compression, swelling pressure and shrinkage rate, to the internal stress that develops at specific gravimetric water contents.

By incrementing the NaCl and CaCl2 concentration of the pore-fluids, the rate of evaporation, shrinkage and drying stress development are all declined. In addition, the shrinkage and internal stress developed at equivalent gravimetric moisture contents is also decreased. This result fit within explanation of traditional drying theories and their mutual relation to the reduction in the water activity and increment in the surface tension, viscosity and density outputted by the augmentation of NaCl and also CaCL2 to the pore-fluid. extensively, and joined with each other, the variation of the solution properties guarantees a decreased evaporation rate and also acts to reduce the shrinkage stress (and strain) advanced in the soil.

A significant expansion to this work would be investigation of the impact of salinity on soil structure. This is a principle ingredient for the extension of the outcomes of this work to the field-scale, especially as it makes a connection to cracking. While this work proposed that soils including a high quantity of salts may need longer desiccation periods to crack and may be capable of stay uncracked (as compared to non-saline soils) when drying periods are short, the complexity of the soil behavior at the field-scale, structural variations and other processes will affect the overall shrinkage and cracking behavior:

1. Salinity can reduce both swelling and shrinking of soil because of its effect on mineralogy and diffuse double layer as mentioned in literature review.

2. Salinity can increase tensile strength of soil, its related to the higher salt solution the denser the soil so more force we need to break the soil, on the other hand it can reduce unconfined compression but higher pressure we need to break the soil its related to more brittle the soil with more salt we have.

3. Hydraulic conductivity increase with salinity due to salts can absorb water and then it can affect the hydraulic conductivity.

4. Salinity reduce swelling pressure because of its effect on diffuse double layer, it can decrease it, and therefore it can swell less than distilled water.

5. With increase of cycles of swelling and shrinking it can decrease the shrinkage.

BIBLIOGRAPHIC REFERENCES.

1. Alamdar-Niemann, M., Bergs-Winkels, D., & Merkens, H. (1991). Educational conditions of Turkish migrant children in German schools. Anthropology & education quarterly, 22(2), 154-161.
2. Arasan, S., & YETİMOĞLU, T. (2008). Effect of inorganic salt solutions on the consistency limits of two clays. Turkish Journal of Engineering and Environmental Sciences, 32(2), 107-115.
3. Basma, A. A., Al-Homoud, A. S., Malkawi, A. I. H., & Al-Bashabsheh, M. A. (1996). Swelling-shrinkage behavior of natural expansive clays. Applied Clay Science, 11(2-4), 211-227.
4. Bowders Jr, J. J., & Daniel, D. E. (1987). Hydraulic conductivity of compacted clay to dilute organic chemicals. Journal of Geotechnical Engineering, 113(12), 1432-1448.
5. Chen, R., & Ng, C. W. W. (2013). Impact of wetting–drying cycles on hydro-mechanical behavior of an unsaturated compacted clay. Applied Clay Science, 86, 38-46.
6. Cui, Y. J., & Delage, P. (1996). Yeilding and plastic behaviour of an unsaturated compacted silt. Géotechnique, 46(2), 291-311.
7. Dragun, J. (1988). The soil chemistry of hazardous materials. Hazardous Materials Control Research Institute.

8. Fredlund, D. G., & Morgenstern, N. R. (1976). Constitutive relations for volume change in unsaturated soils. Canadian Geotechnical Journal, 13(3), 261-276.

9. Gens, A., Sánchez, M., & Sheng, D. (2006). On constitutive modelling of unsaturated soils. Acta Geotechnica, 1(3), 137.

10. Kaya, A., & Fang, H. Y. (2000). The effects of organic fluids on physicochemical parameters of fine-grained soils. Canadian Geotechnical Journal, 37(5), 943-950.

11. Liua, Y., Tagueb, J., & Somayajulub, R. (2016). What Do Eighth Grade Students Look for When Determining If a Mathematical Argument Is Convincing. International Electronic Journal of Mathematics Education, 11(7), 2373-2401.

12. Lloret Morancho, A., Villar, M. V., Sanchez, M., Gens Solé, A., Pintado Llurba, X., & Alonso Pérez de Agreda, E. (2003). Mechanical behaviour of heavily compacted bentonite under high suction changes.

13. Mahasneh, B. Z. (2004). Dead Sea water as a soil improvement agent. Electronic Journal of Geotechnical Engineering, 9(1).

14. Mansour, S. A., Heikal, T. M., Mossa, A. H., & Refaie, A. A. (2008). Toxic effects of five insecticides and their mixture on male albino rats. Journal of the Egyptian Society of Toxicology, 39, 85-94.

15. Ören, A. H., & Kaya, A. (2003). Some engineering aspects of homoionized mixed clay minerals. Environmental monitoring and assessment, 84(1-2), 85-98.

16. Osipov, V. I., Bik, N. N., & Rumjantseva, N. A. (1987). Cyclic swelling of clays. Applied clay science, 2(4), 363-374.

17. Park, J. H., Widi, G. A., Gimbel, D. A., Harel, N. Y., Lee, D. H., & Strittmatter, S. M. (2006). Subcutaneous Nogo receptor removes brain amyloid-β and improves spatial memory in Alzheimer's transgenic mice. Journal of Neuroscience, 26(51), 13279-13286.

18. Peron, H., Laloui, L., Hueckel, T., & Hu, L. B. (2009). Desiccation cracking of soils. European journal of environmental and civil engineering, 13(7-8), 869-888.
19. Petrov, B., & Cvetković, D. M. (1997). Community structure of branchiopods (Anostraca, Notostraca and Conchostraca) in the Banat province in Yugoslavia. In Studies on Large Branchiopod Biology and Conservation (pp. 23-28). Springer, Dordrecht.
20. Popesco, P. (1980). Atlas of topographical anatomy of farm animals, 2.
21. Rao, S. N., & Mathew, P. K. (1995). Effects of exchangeable cations on hydraulic conductivity of a marine clay. Clays and clay minerals, 43(4), 433-437.
22. Shariatmadari, N., Salami, M., & KARIMPOUR, F. M. (2011). Effect of inorganic salt solutions on some geotechnical properties of soil-bentonite mixtures as barriers.
23. Sivapullaiah, P. V., & Manju, M. (2006). Effect of zeolitization on the volume-change behaviour of kaolinitic soils. Canadian geotechnical journal, 43(9), 969-978.
24. Sridharan, A., Abraham, B. M., & Jose, B. T. (1991). Improved technique for estimation of preconsolidation pressure. Geotechnique, 41(2), 215-268.
25. Tawfiq, S., & Nalbantoglu, Z. (2009, May). Swell-shrink behavior of expansive clays. In 2nd International Conference on New Developments in Soil Mechanics and Geotechnical Engineering, Near East University, Nicosia, North Cyprus.
26. Yukselen-Aksoy, Y., Kaya, A., & Ören, A. H. (2008). Seawater effect on consistency limits and compressibility characteristics of clays. Engineering Geology, 102(1-2), 54-61.
27. Zhan, T. L., & Ng, C. W. (2006). Shear strength characteristics of an unsaturated expansive clay. Canadian Geotechnical Journal, 43(7), 751-763.

DATA OF THE AUTHORS.

1. Yaser Vanda. Department of Civil Engineering, Eastern Mediterranean University, Cyprus.

2. Saber Avestakh. Sharif University of Technology - Department of Civil Engineering, Tehran, Iran.

RECIBIDO: 6 de febrero del 2019. **APROBADO**: 21 de febrero del 2019.