

# **JOURNAL OF GREEN SCIENCE AND TECHNOLOGY**

## **OBSERVATION OF CLAY SETTLEMENT OF CONSOLIDATION IN PETARUKAN DISTRICT PEMALANG REGENCY STABILIZED BY USING SALT (NaCl)**

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### **Abstrak**

Soil stability is an effort made to improve the properties of the origin of the soil, basically stabilization using salt has the same principle as stabilization using other chemicals. Based on the research on native soil combat, the value of 42.25% is categorized into soil types have high plasticity therefore the soil needs repair or stabilization.

In this study chemical stabilization was carried out by adding ingredients to stability of salt (NaCl) with a percentage of 4% , 8%, and 12% of the weight of the sample. The research method used is divided into two, namely physical properties test consisting of water content test, density test, atterberg test and filter analysis test and mechanical properties test consisting of compacting test and consolidation test .

The results of physical properties test showed that the greater the percentage of NaCl addition in water content, plastic limit, shrinkage limit increased while the specific gravity value, liquid limit, plasticity index and pass filter No. 200 decreased. While in the compaction test the weight value of the maximum dry volume increases and the optimum water content value decreases along with the percentage addition of NaCl. The maximum weight value of maximum dry volume is 1.675 gr / cm<sup>3</sup> and the lowest optimum water content is 15.509% in mixed soil with the percentage of addition of 12% NaCl. Meanwhile the consolidation test results showed that the greater percentage percentage of NaCl consolidation coefficient (Cv) increases , while for the Cc index value and the consolidation decrease (Sc) decreases.

**Keywords : *clay soil, Stablizing,Consolidation , salt (NaCl).***

## **I. INTRODUCTION**

### **A. Background**

The phenomenon of swelling and shrinkage is a characteristic of the most typical cohesive soil. This phenomenon occurs due to changes in soil, water content. The tropical climate in Indonesia has a large potential to support changes in water from optimum to the minimum, thus affecting expansive land. The land experiences movement due to changes in the volume of the soil so that the strong value of the soil support is always changing which results in damaging the structure above.

Land in Petarukan sub-district, Pemalang district includes inorganic clay soils with high plasticity and clay soil with a high plasticity index. This was identified by the presence of cracked, swollen and hard soil during the dry season, while in the rainy season the soil turned soft. This condition causes the road surface to be much bumpy and cracked, so it is necessary to improve the soil properties so that it can support the construction above it.

Soil stabilization is a soil improvement that allows the soil to be better which can be done by compacting with mechanical devices. Can also be done by adding mixed ingredients (additives), for example, chemical mixing materials such as cement, lime, rice husk ash and so on. In this study using kitchen salt (NaCl) as a stabilizing agent. The choice of kitchen salt (NaCl) due to NaCl solution can increase the force of cohesion between particles so that the particle bonds become more dense (Bowles, 1984).

### **B. Problem Formulation**

From the problems raised in the background can be formulated:

1. The soil structure conditions in Petarukan Subdistrict are clay soil with a high plasticity index and need to be repaired.
2. What is the physical properties of clay in Petarukan Subdistrict, Pemalang Regency before and after stabilization with kitchen salt (NaCl).

3. How big is the change in the consolidated value of the consolidated clay in Petarukan Subdistrict, Pemalang Regency before and after stabilization with kitchen salt (NaCl) with a variation of the mixture of 4%, 8%, and 12% of the sample weight.

### **C. Research purpose**

The purpose of the research is as follows:

1. Knowing the physical properties of clay soil in Petarukan Subdistrict, Pemalang Regency before and after stabilization with kitchen salt (NaCl) with variations in mixture of 4%, 8%, and 12% of the sample weight.
2. Determine the change in the value of consolidated decline in clay in Petarukan Sub-district, Pemalang District before and after stabilization with kitchen salt (NaCl) with a variation of the mixture 4%, 8%, and 12% of the sample weight.

### **D. Benefit Of Research**

The benefit of this research is:

- A. The results of this study are expected to provide knowledge about changes in physical and mechanical properties of the land in Petarukan Subdistrict, Pemalang District which is stabilized with kitchen salt (NaCl).
- B. Provides alternative ingredients for stabilizing clay soils with a salt stabilizing agent (NaCl).
- C. As a material consideration for agencies and other parties related to the condition of the land in the area, so that it can plan a safe and comfortable construction for its users.

## E. Scope Of problem

Limitations include the following:

1. The research was carried out in the Civil Engineering Laboratory of Soil Engineering Swadaya Gunung Jati University for testing the physical properties of Proctor standards, and consolidation testing.
2. Soil samples were taken from Petarukan district, Pemalang regency, soil samples taken in disturb samples with a depth of  $\geq 30$  cm and samples of air-dried soil.
3. Varies of kitchen salt mixture (NaCl) as stabilizing material 4%, 8%, and 12% of soil sample weight.
4. In a mixture of kitchen salt (NaCl) soil samples were ripening for  $\pm 24$  hours.
5. Kitchen salt (NaCl) used is kitchen salt (NaCl) from traditional market vendors.

## F. Research Stage

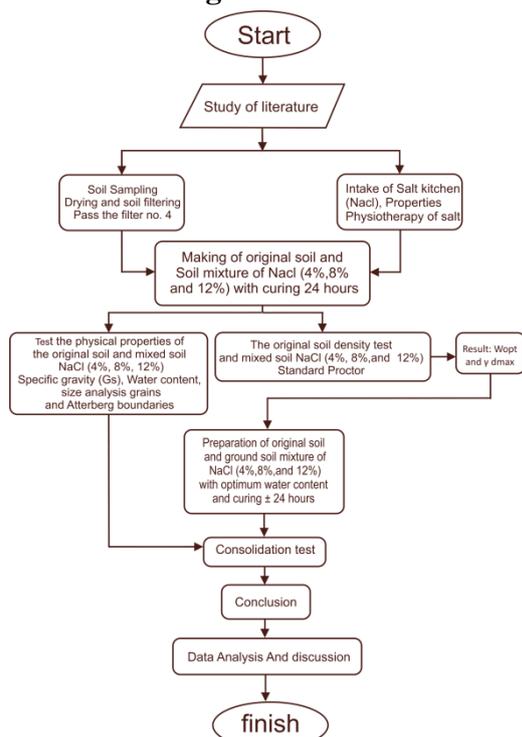


Figure 1. Flowchart research

## II. REVIEW OF REVENUE AND THEORETICAL BASIC

### A. Similar Research Review

Sri Endah Mujiwati (2017) with the title "Review of Decreased Stabilization of Sukodono District Clay Soil Consolidation

with Kitchen Salt (NaCl)". The results of the interim study showed that  $LL = 86.00\%$ ,  $PL = 34.32\%$ ,  $PI = 51.77\%$  based on these results constituted inorganic clay high plasticity.

The classification results according to AASHTO native soil and mixed soil are included in group A-7-5. Classification results of soil, according to USCS native soil, soil mixture of 5%, 10% and 15% NaCl are included in the CH group, while for soil mixed with NaCl 20% the soil enters the MH group.

The results of the Standard Proctor compaction test show that the greater the percentage of the mixture of kitchen salts the maximum dry volume is increased while the optimum water content decreases. The maximum dry volume weight of the original soil is  $1.265 \text{ gr / cm}^3$ , the highest maximum dry volume, weight value is obtained at the percentage of 20% mixture of kitchen salt which is  $1.368 \text{ gr / cm}^3$ . The optimum moisture content in the original soil is 27.5%, while the lowest optimum moisture content is obtained in mixed soil with a percentage of 20% salt in the kitchen, which is 24.3%.

The results of the consolidation test show that the greater the percentage of the mixture of kitchen salt the value of  $C_v$  increases. The value of  $C_v$  in the original soil is  $0.0158 \text{ cm}^2 / \text{Sec}$ , and the maximum  $C_v$  value occurs in mixed soil with a percentage of 20% of kitchen salt of  $0.0194 \text{ cm}^2 / \text{Sec}$ . As for the  $C_c$  and  $S_c$  values, the greater the percentage of kitchen salt

### B. Theoretical Basic

#### 1. Clay Soil

Is a soil with microcononic size up to sub microconents that come from the weathering of constituent chemical elements rock. Clay is very hard in dry conditions, and not easy chipped only with your fingers. Very clay permeability, low, plastic in moderate water content. In western America, for clay, whose plastic condition is characterized by its form soapy or like made of wax is called "gumbo". Whereas on water conditions that are higher in clay soil will be sticky

(cohesive) and very soft. (Terzaghi, 1987).

**2. Salt kithcen**

The NaCl structure includes the anion in the middle and the cation occupies the octahedral cavity. The salt solution is an electrolyte, which has a brown movement on the surface that is larger than the brown movement in pure water so that it can reduce water and this solution to the force of cohesion between particles so that the particle bonds become tighter (Bowles, 1984).

Kitchen salt is a collection of chemical compounds whose main part is sodium chloride (NaCl). If the clay element (Si) is reacted with NaCl and water will produce Na<sub>2</sub>SiO<sub>3</sub> and 2HCl.



In the above reaction it can be concluded that the soil can react with NaCl. This reaction is called the ion exchange reaction. The addition of NaCl will cause the pulling process to pull ions from soil particles with cations from NaCl and NaCl particle cations with anionic water particles.

**3. Soil Stability**

Soil stability is an effort made to improve the properties of soil origin basically stabilization, which uses salt has the same principle as stabilization that uses other chemicals. The advantage is to increase the density and increase the strength of the soil. Land with high LL (liquid limits) usually gives a good reaction with the addition of this salt (Ingles and Metcalf, 1972).

**III. RESULTS AND DISCUSSION**

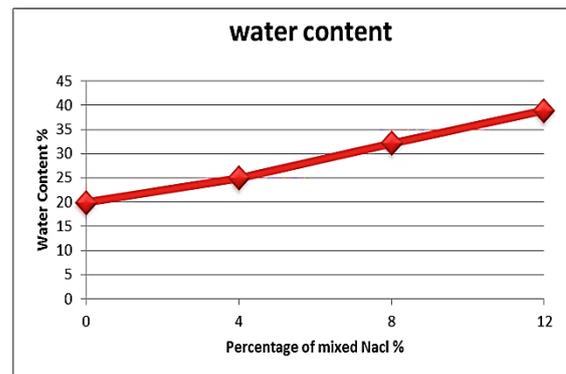
**A. Physical Propertise Test**

**Tabel 1.** Test Physical Properties of Mixed Soil with Addition of NaCl

No.	Testing type	Orginal Soil	Presentation of adding nacl		
			4%	8%	12%
1.	Water Content	19,886%	24,975%	32,12%	38,938%
2.	Specific Gravity	2,673	2,599	2,571	2,467
3.	Liquid Limits	54,43%	49,06%	46,19%	41,02%
4.	Plastic Limits	12,185%	26,147%	27,277%	28,975%
5.	Index Plastisitas	42,25%	22,91%	18,91%	12,06%
6.	Pass the sieve No. 200	88,66%	85,443	83,871%	51,486%
7.	Klasifikasi AASTHO	A - 7	A - 7	A - 7	A - 7
8.	Klasifikasi USCS	CH	ML	ML	CL

**1. Water content**

From the results of the water content research, the following graph is obtained:

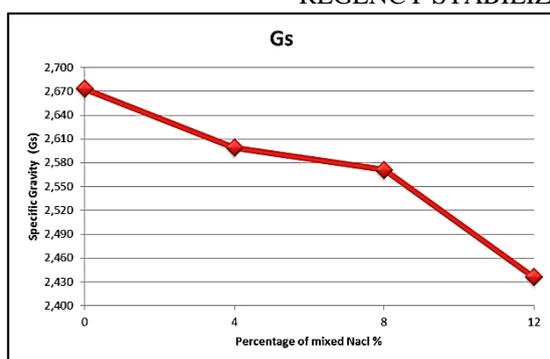


**Figure 3.** Graph of the relationship between water content and percentage of NaCl

In the graph above, the higher the addition of NaCl, the higher the water content. This increase in water content occurs because salt has a long enough water binding properties.

**2. Specific gravity**

From the results of the Specific gravity research, the following graph is obtained:

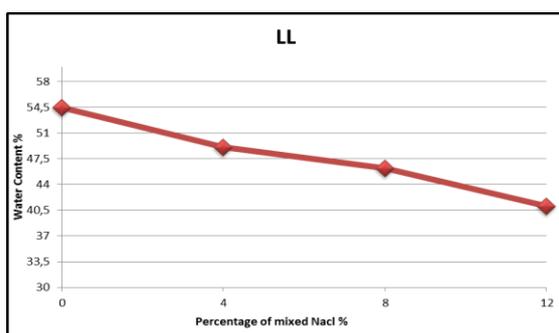


**Figure 4.** Graph of the relationship between Specific Gravity (Gs) and percentage mixed NaCl

In the graph above, it is seen that the higher the percentage of addition of kitchen salt, the lower the specific gravity value. This is because there are 2 mixed materials that have different specific gravity values.

### 3. Liquid Limits

From the results of Liquid Limits research, the following graph is obtained:

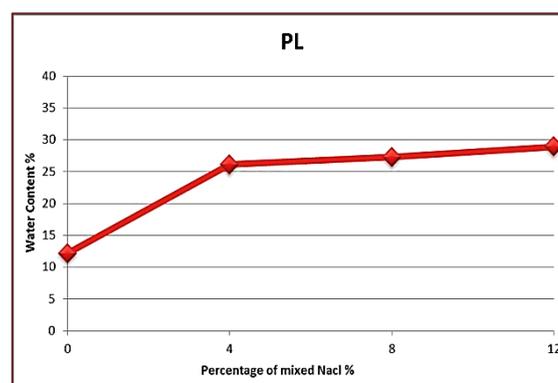


**Figure 5.** Graph of the relationship between liquid limit (LL) and the percentage of NaCl mixture

In the graph above it can be seen that the higher the percentage of adding salt, the lower the Liquid limit value. This decrease occurs because the addition of NaCl makes the soil granules become large so that it will reduce the attractiveness of the particles which also means reducing the value of cohesion. particles in clay have a negative electrical charge. An ideal crystal, negative and positive charges must be balanced. To compensate for the negative charge, clay particles attract positive charge ions (cations) from salts present in pore water (Hardiyatmo, 2010).

### 4. Plastic Limits

From the results of the Plastic Limits research, the following graph is obtained:

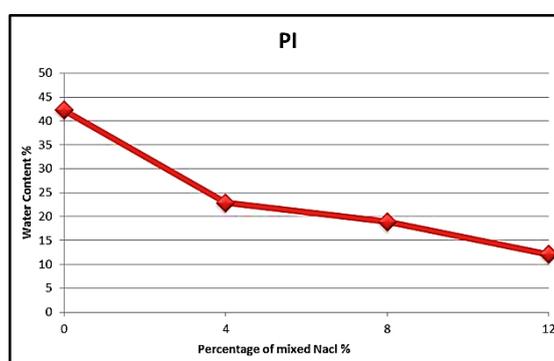


**Figure 6.** Graph of the relationship between plastic limits (PL) and the percentage of NaCl mixture

In the graph above, the higher the percentage of addition of salt, the value of Plastic limit increases. This is due to the pulling process of ions from soil particles with cations from salt water. The attractiveness of particles will reduce the cohesion value in the soil which causes bonding between the grains and the other to be less sticky. Then the greater the percentage of mixed salt (NaCl) plastic limit value will increase.

### 5. Plasticity Index

From the results of the Plasticity Index research, the following graph is obtained:



**Figure 7.** Graph of the relationship between plasticity index (PI) with mixture of NaCl addition

The results of this Plasticity index are directly proportional to Liquid limits,

the more NACL is added, the more the Plasticity index value drops.

### 6. Grain Analysis

From the results of the Plasticity Index research, the following Table is obtained:

**Table 2.** Test results of grain gradations on native soil and mixed soil

No. Sieve	Diameter (mm)	Original Soil	Addition of salt kitchen NaCl		
			4%	8%	12%
No. 4	4,75	100	98,866	98,474	74,534
No. 8	2,36	99,783	96,586	95,826	69,337
No. 16	1,18	99,620	95,463	94,566	66,689
No.20	0,85	99,517	94,971	94,154	64,994
No.40	0,425	98,983	93,551	92,886	60,186
No. 80	0,180	96,083	90,869	90,294	56,040
No. 100	0,150	93,531	89,100	88,271	54,497
No. 200	0,075	88,666	85,443	83,871	51,486

From the table above it can be concluded that the more NACL additions, the percentage of the number that passes the No. filter. 200 is getting down. This is because mixing salt (NaCl) makes the size of the granules bigger.

## B. Mechanical Propertise Test

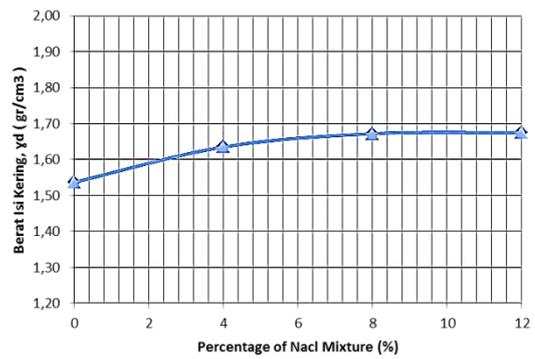
### 1. Compaction test (Standar Proctor)

From the results of the Compaction test, the following Table is obtained:

**Table 3.** Proctor standard test results on original soil and mixed soil

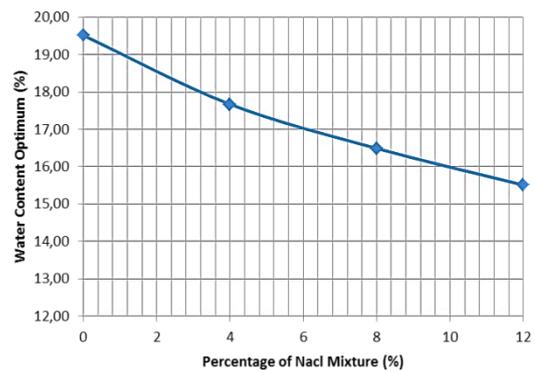
Sample	Variation	W <sub>opt</sub> (%)	γ <sub>d maks</sub> (gr/cm <sup>3</sup> )
1	Original soil	19,51	1,537
2	Original soil + 4% Nacl	17,67	1,635
3	Original soil + 8% Nacl	16,49	1,672
4	Original soil + 12% Nacl	15,509	1,675

Based on Table 5.4. can be graphed the relationship between maximum dry volume weight and NaCl mixture percentage and the graph of the relationship between the optimum water content and the percentage of NaCl mixture can be seen in Figures 3.6 and 3.7.



**Figure 8.** Graph of the relationship between dry volume weight and percentage NaCl mixture

This is because kitchen salt acts as a filter that will fill the air cavities in the soil. During the compaction process, the air that is in the soil will come out and the granules of kitchen salt will fill the cavity so that the soil becomes solid so that the value of dry volume weight increases with mixing of kitchen salt.



**Figure 9.** Graph of the relationship between optimum water content and percentage NaCl mixture

### 2. Consolidation test

From the results of the Consolidation, the following Table is obtained:

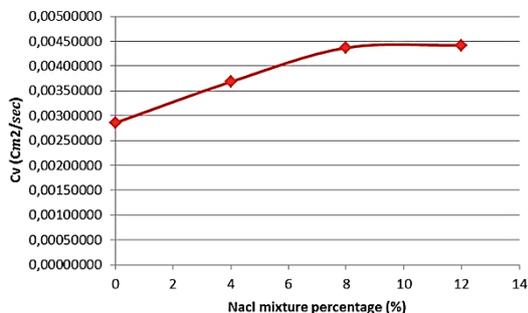
**Table 4.** Consolidated test results on original soil and mixed soil

Addition of kitchen salt	Coefficient of Consolidation (Cv)	Compression Indes (Cc)	Settlement of Consolidation (Sc)
%	Cm <sup>2</sup> /dtk		Cm
Original soil	0,00285733	0,1266	0,0639
4	0,00368308	0,1207	0,0469
8	0,00436861	0,0214	0,0082
12	0,00442024	0,0117	0,0043

Based on the results of the consolidation test, the Coefficient of

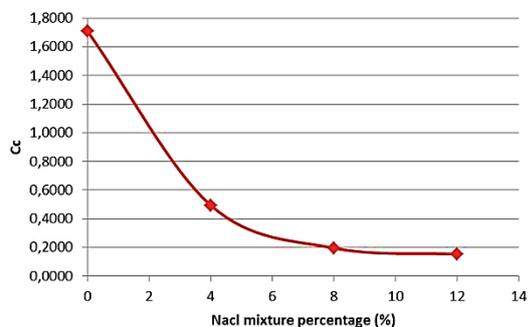
OBSERVATION OF CLAY SETTLEMENT OF CONSOLIDATION IN PETARUKAN DISTRICT PEMALANG REGENCY STABILIZED BY USING SALT (NaCl)

Consolidation, Compression index and Settlement of Consolidation values of these values can be graphed the relationship between these values and the percentage of NaCl can be seen in Figures 3.8, 3.9 and 3.10



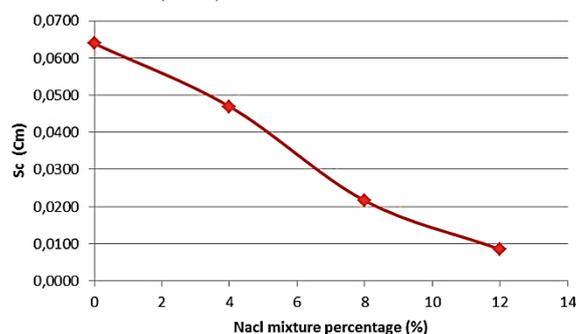
**Figure 10.** Graph the relationship between coefficient of consolidation and percentage of NaCl mixture

Figure 3.8. shows the faster the consolidation that occurs, this is because the salt solution makes the grain of the soil become large, so if there is pressure from the loading then the water is relatively quickly out of the ground.



**Figure 11.** Graph the relationship between compression index and percentage NaCl mixture

The greater the percentage of kitchen salt mixture, the smaller the Cc value so that the smaller the decrease occurs. This happens because the cavity in the soil is filled with kitchen salt so that the soil grains become denser, denser and less easily absorbed.



**Figure 12.** Graph of the relationship between Settlement of consolidation and the percentage of NaCl mixture

This is because the value of the settlement of consolidation (Sc) is strongly influenced by the value of the compression index (Cc), both of these values are directly proportional. So if the compression index (Cc) value decreases, the settlement of consolidation (Sc) value also decreases.

#### IV. CONCLUSION

Based on the results of research at the Civil Engineering Laboratory of Soil Engineering in Gunung Jati Swadaya University, the following conclusions can be drawn :

##### 1. Water Content

In the Water content test, the highest value of 12% salt addition was 38.938%, while the smallest in the original soil was 19.886%.

##### 2. Specific Gravity

In the Specific Gravity Test the highest value was obtained on the original soil, which was equal to 2.673, while the smallest amount of salt was added to 12% of 2,467.

##### 3. Liquid limits

In Liquid limits test, the highest value is found in the original soil, which is 54.43%, while the smallest amount of salt is 12%, 41.02%.

##### 4. Plastic Limits

In the Plastic limits test, the highest value for 12% salt addition is 28.975%, while the smallest in the original soil is 12.185%.

5. Index Plasticity

The plasticity index obtained the highest value on native land, which was 42.25%, the smallest at 12% salt addition of 12.06%.

6. Sieve Analysis

The Sieve analysis test found that the highest value in the original soil was 88.666%, while the smallest at 12% salt addition was 51.486%.

7. Soil Classification

In the Classification system according to AASTHO all samples are included in the A-7 class. While the Classification System according to USCS of native soil into CH class while in the addition of 4%, 8% belong to the ML group and the addition of 12% including CL.

8. Compaction test

In the Compaction test, the highest value of Woptimum on the original soil was 19.51%, the smallest at 12% salt addition of 15.509%. And the maximal  $\gamma_d$  value of Woptimum is the largest addition of 12% at 1.675 and the smallest at original land, which is equal to 1.537.

9. Consolidation test

In the Consolidation test, the highest Cv value for 12% salt addition was 0.00442024, while the smallest in the original soil was 0.00285733. And the values of Cc and Sc are the opposite of the value of Cv. The highest on the original soil and the smallest at 12% increments respectively as follows, Cc native soil 1.7105 adding 12% salt 0.1533. And the Sc value of the original land is 0.0639 and the addition of 12% salt is 0.0085.

10. Utilization of research in the field of civil engineering

The usefulness of this research in the field of civil engineering is to be able to reduce the amount of land heaped on making new roads in villages or plantations. the principle of hoarding is to keep the surface of the ground away from

the ground water level so that the water does not rise to the surface so that it affects the building or construction above it. But using salt stability materials can prevent water from rising to the surface. There is such a thing as soil capillarity, the soil capillary is inversely proportional to the size of the soil, the smaller the soil, the greater the capillarity. This is not good for buildings above because the soil contains a lot of water. But with the addition of salt between the inter-soil cavity filled with granules of salt at the time of compaction, so that the water does not rise to the surface, and suppresses the water so that it quickly exits and the heap of soil can be reduced.

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