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Buildings are prevented slides on expansive soils with methods of load channeled and structures acceptable

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Abstract. Research location in Tangkil villages, Citeureup Sentul, narrow land, landslide-prone soil on contoured land structure with 11 buildings and some infrastructure .
Objectives: Constructed infrastructure and buildings were in a narrow area, with expansive soil. Groundwater was channeled by subdrain and the soil was clamped with a retaining wall structure and counterfort so that the horizontal force was held back, and the structure was by plan age.
Observation in the project site, secondary data based on geology, hydrogeology, and soil test. topography.
The novelty is that the buildings and infrastructure were success the no more repair constructed. The cost of the structure constructed was cheap because water pressure has been horizontal channeled
The solution should be understood easily by field engineers. The force is partially channeled through the PVC pipe so as not to burden the structure and residual the force to be restrained on the structure.
To prevent the retaining wall, counterfort (stiffener) from being seen, then the retaining wall is placed under the stairs of the building so that the building and infrastructure did not crack, or tilt. The solution applies to all countries where the soil is easily sliding, existing land contour should be maintained
Keywords: expansive soil, sub drainage, retaining wall, no shear collapse occurs, unity of tied beam and plate

1. Introduction

Bemmelen (1949) and Koesoemadinata (1963), have almost the same assumptions about tectonic events that occurred in the Bogor Zone **(ESDM, 2011).** Two tectonic periods have occurred in the Bogor zone, i.e., the Intra Miocene tectonic period and the Plio-Plistocene tectonic period. As for the Bogor-Jakarta area, Sukardi (1982) distinguished it into Tertiary Tectonic and Quarter Tectonic (Neotectonic). In the Plio-Plistocene Tectonic Period, there was also a process of folding and enlargement caused by Northward-facing forces. The force was caused by subsidence in the Northern Bandung Zone, then created strong pressure in the Bogor Zone, and formed a folded structure and the fault rises to the North. Furthermore, Sukardi (1986) explained that perhaps this Plio-Plistocene tectonic movement was one of the reasons why the Northern region was not exposed to (unaffected) Tertiary rocks. This was due to the existence of transverse fractures that more or less lead North-Northwest to South-Southeast.

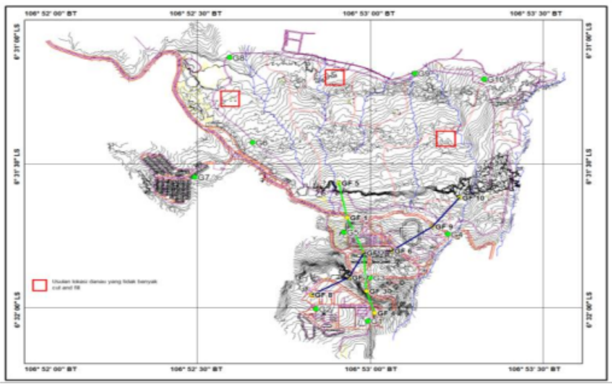


Fig.1. Location TS1 until TS8

Table 1. Clay Minerals Relation with Sentul Area Activity (Skempton, 1953)

No	Sample	IP	% Clay	Activity	Clay Mineral
1	TS 1	43,55	37	1,177027	Illite
2	TS. 2	41,39	44	0,9406818	Kaolinite
3	TS.3	14,95	4	3,7375	Ca – Montmorillonite
4	TS.4	35,32	29	1,217931	Illite
5	TS.5	55,14	59	0,9345763	Illite
6	TS.6	52	53	0,9811321	Illite
7	TS.7	35,39	43	0,8230233	Kaolinite
8	TS. 8	60,81	48	1,266875	Illite

Excess water is a disaster for buildings on expansive land, sub-drainages are installed under houses, and roads and, solutions to overcome excess water. To prevent sliding potential from high to low contours. Maintains the terraced traits and absorbs water. **Driscoll, R. (1983).**
The building does not move in the area of sliding potential by creating retaining walls that provide strength. The lower and upper structures calculate the workforce. The structure does not withstand all forces, but the air distribution does not compress the structure so it is cheap and has a long life. **Bo Chen, *et. al.* (2020)**
All expansive soil solutions are not suitable for community conditions, and natural environmental conditions, as far as possible using local materials for ease of construction. **Triastuti, N.S. (2017).**
Planted trees should have roots that absorb water and prevent landslides such as mahogany trees for highland locations and some land filled with surface water to absorb groundwater. **Triastuti, N.S. (2018).**
Solving cases, of course, has both financial and non-financial effects, utilizing useful local materials, at an optimal cost. Provide achieved safety solutions forever. If a disaster occurs, then

the damage happens to the poorest people, so the state or local government must require excessive time, money, and energy to deal with the disaster. Expansive soil as soil or rock that has the potential to shrink because of water content was changed. Expansive soil such as soil or rock that the potential to shrink as theiitser content changes. The decrease in the upper structure causes it not to be uniform. **Chen, F.H. (1988)**.

Expansion soil of the montmorillonite mineral is structurally bound by H2O ions, it is very easy to infiltrate so that the montmorillonite mineral is very unstable, under stagnant conditions, **Liu, *et. al.*** (2014), water easily seeps into the cracks of the dry layer so that the minerals shrink.

The soil consists of 3 components. **Al-Rawas, A.A. *et. al.* (2016),** namely air, water, and solid materials. Soil technical properties are affected by water, air does not technically affect. The soil is said to be saturated if the voids are filled with water and the water content is zero when the soil is dry.

Expansive soil characteristics are different from other soil types, namely:

1. Clay, changes in volume, the mineral content of clay is usually montmorillonite or vermiculite where acyl and kaolinite expand into very fine particles.
2. Soil Chemistry, increasing the concentration and valence of cations can inhibit soil development.
3. Plasticity, high plasticity index, and the liquid limit of the soil, the swelling potential is greater.
4. Structural solutions, clay tends not to be cheap compared to other soil structures.
5. The high dry density possessed by the dry weight of the soil indicates a small particle distance, meaning large repulsive forces and high expansion potential.

Changes in relatively low water content must be maintained so that the nature of the expansion of the soil in the dry season changes to the rainy season, and there is no significant change in volume. Or by changing the properties of the clay.

Based on some references that are,

1. Holtz and Gibbs (1956), classified the degree of shrinkage based on colloid content, plasticity index, and shrinkage limit.
2. Chen (1965), referring to the Fluid Limit. Classifying the degree of land development. Chen (1988), refers to the Plasticity Index class as satisfying the degree of swelling of the soil.
3. Roman (1967), Classification of expansive soil refers to the shrinkage and plasticity index, classification of the degree of soil development.

Table 2. below, three expert statements indicate Plastic Index > 32, Holtz and Gibbs (1956): Shrinkage limits, Roman (1967), different shrinkage index. The colloid content was proposed by Holtz and Gibbs (1956), 2 greatly different experts between Holtz and Gibbs (1956)>30, Chen>10 (1965), for very high expansive soils.

Table 2 Plasticity and shrinkage index underlying the Expansive Soil Classification Index.

				Data based on index tests				
CC *1	PI*1	PI *2 (1988)	PI*3	SI(%)* 3	SL *1	PE*1	PE *2	DOE
>28 20-31	>35 25-41	>35 20-55	>32 23-32	>40 30-40	<11 7-12	>30 20-30	>10 3-10	Very.High High

13-23 <15	15-28 <18	10-35 0-15	12-23 <12	15-30 <15	10-16 >15	10-20 <10	1-5 <1	Medium Low

Description:

a. SL = Shrinkage Limit.
b. SI = Shrinkage Index.
c. PI = Plasticity Index.
d. DOE = Degree of Expansion.
e. CC = Colloid Content (% minus 0.0001 mm)

This study encourages reducing the amount of cement used in soil stabilization. The formation of cementation such as calcium aluminum hydrate (CAH) in the good treatment samples of the triaxial test results was observed, and newly formed compounds cleaner and more sustainable environment for the use of RT (Recycle Tile). AL-Bared, M.A.M, *et. al*. (2019).

The shear strength increases to a peak value and then decreases when the suction exceeds a specific value corresponding to the peak shear strength. Bo. C, *et. al*. (2020).

Comparing the theory of shear strength of unsaturated soils from several real cases, the accuracy and rationality of this model were validated. This formula has the convenience and flexibility of five parameters (for the effective stress model) or six parameters (for the shell casing model), the MC strength parameter of the saturated soil, and the installation parameters of SWCU Genuchten van USW DengD, *et. al*. (2020).

The difference between the pseudo-static and pseudo-dynamic approaches was drawn from the conservative method, but it still gives a fairly precise result as the pseudo-dynamic approach if the seismic wavelength value is high or large, the soil structure is small. **Huang, Q. *et. al*. (2020)**.

The suction value in the CWCC (constant water content triaxial compression) test because SSM (The Suction stress-SWCC Method) is not limited by the cavitation phenomenon. The application of SSM is expected to reduce the time required and the projected costs with additional equipment such as a pore water meter in the CWCC test. **Kim BS, *et. al*. (2019).**

This experimental data is to predict vertical drop (sp), horizontal deformation (hdp) and tilt (tp) square footing of sand reinforced at each load applied where dependent variables are predicted decrease (sp), horizontal deformation (hdp), and slope (tp) respectively. **Kaur, A. and, Kumar, A. (2016).** The experimental data is to predict vertical degression (sp), horizontal deformation (hdp), and slope (tp) of the reinforced square sand footing at each applied load where the dependent variables are predicted to decrease (sp), horizontal deformation (hdp) and slope (tp), respectively. **Kaur, A. and, Kumar, A. (2016)**

The angle of internal friction and the sand layer interface increases with increasing relative density and decreases with increasing oil content. The oil properties (particularly viscosity) play a major role in the interface frictional behavior.

The SS interface of shear strength is always higher than the soil-material interface. Although the friction angle of sand contaminated with viscous liquid has decreased dramatically, it is compensated by the adhesion and cohesion formed between the soil grains and the construction material. **Mohammadi, A, *et. al*. (2020).**

The larger S1 structure illustrations with greater sway and less sliding response due to the SSSI effect, while the increased shear response and structural stiffness due to shock and decrease in the moment-to-shear ratio (M/HL) of the S2 structure tend to slide more than the reference test. **NgoV-L, *et. al*. (2019)**

A significant change in volume with increasing water content during the rainy period so that the shallow avalanche of the original slope surface is not saturated and will show changes. The characteristics of the suction matrix, shear strength, including the change in stress distribution with depth and time. **Shunchao, Q, *et. al.* (2019).**

The final bearing capacity of the sample with three ordinary sand columns (OSC) was finally about 11% greater than the sample with OSC. The effect of the number of horizontal reinforcement layers, the length of the vertical package, and the number of the sand column were investigated, the increase in bearing capacity and economy.

In addition, the comparison of the reinforcement modes of the four horizontal layers of the geotextile achieves similar performance to high column wrap geotextile to the 50% from the point of view of increasing strength, while the geotextile required to wrap one column is approximately 2.5 times of the required geotextile for four layers. **(Shamsi, M. *et. al.* 2019)**.

The decrease in the efficiency of the grouting process and until the completion of grouting will continue to decrease as time goes by. The three-dimensional predictive model of the proposed dynamic relationship with the grouting tie complements the compaction radius of the grouting which can more accurately evaluate the effectiveness and efficiency. **(Xu, X-H, *et. al.* 2020).**

Objective: To build infrastructure and buildings on a narrow area, expansive soil must be careful, and the existing horizontal forces must be partially removed at all times so that each building and infrastructure does not collapse or break down. The solution must be cheap, and easy to construct, and groundwater must be channeled, maintaining the contours of the soil.

Overcoming a large area in the project must be practical, not theoretical, easy to digest by executors, and project supervisors, easy to implement, and quick to install. The author provides a solutions project work so that it can be accepted by all parties and does not cause landslides, cracking, or damage, easy to implement quickly and has been tested since 2012, all buildings and infrastructure are made without any indication of possible building failure.

2. Material and Method

Case study methodology, survey results were to overcome cracks, sloping buildings, and infrastructure over ground that is easy to slide with direct surveys and provide solutions based on primary and secondary data, with the philosophy of horizontal forces at all times pressing the building must be partially distributed and the rest accept a concrete structure so that the structure concrete did not have to have large dimensions and its service life can be longer. Observation of primary land data in the field is:

1. Color of soil, properties of soil,
2. Surface water from the hill is very heavy, the direction of the water flow, the water discharge is large,
3. Behavior of soil is easy to slide, ground cracks thoroughly in hot the season,
4. A stone with a diameter of 3 m was only embedded and shifted 2 m in just one night,
5. The difference in the contours of the hills and lowlands with a large surface water content is the main effect of shear,

Secondary data:

1. Data from the geology survey team,
2. Hydrogeology, rock data, soil history of geology the survey team,
3. Soil investigation, Result of laboratory and site land,
4. Precipitation and hydrology analysis from hydrologists,
5. Topography survey,

6. Indonesian Concrete Standard, Indonesian Load Standard, Indonesian Earthquake Standard.

3. Result

The buildings and infrastructure were succes constructed and operated No repeat construction and added strengthen , so the first constructed until operated no problem.The author analyzes the philosophy that the load was not completely restrained, but partially distributed, the remaining forces are restrained so that the structure becomes inexpensive, and it is hoped that the structure will not experience long fatigue.
Groundwater and soil fertility must be maintained as a source of life. Expansive soil solutions in the village must utilize local materials and simple work tools that are easy to obtain, easy to implement, inexpensive, and non-destructive. Surface water that seeps into the ground, stored just below the ground surface, easily displaces buildings and infrastructure.

The results of the above-mentioned slope stability analysis show that generally, the Northern area which is composed of clay from the Jatiluhur formation expands at an angle of 21° if a safety grade of 1.75 is used, then the area has a slope, and the stability is below the allowable safety grade (Table 1). Clays with a thickness of 5 m generally have a safety grade of < 1.75, only at locations TS. 8 above the safety level of 1.75 on the condition that the area must have good drainage so that the clay can be dry. Security grade > 1.75 can be achieved at locations TS. 6 and TS. 8 when the thickness of the clay layer is only 4 m.

4. Discussion

To build infrastructure and buildings in a narrow area must be careful so that the construction of infrastructure buildings and buildings did not affect each other and cause damage. Expansive soil used for the multi-multi-storying of more than 2 floors should use a deep foundation, but horizontal the force is retained with retaining wall and counterfort while building with a maximum of two floors and infrastructure uses circle concrete pipes without changing the position of the soil by putting the circle concrete pipe in the ground and taken circle concrete pipe down, then poured concrete.
Soil classified as unstable can damage buildings and building infrastructure. A very high rate of expansion and shrinkage of the soil becomes very dangerous, soil stabilization method is one of the efforts to obtain soil properties that meet engineering requirements. The expansive soil at Tangkil Village according table 3 below

Table. 3 The classification of expansive soil - Location in the Tangkil villages Kec. Citeureup. Sentul is based on Atterberg Limit Test

No	Depth	Atterberg	Limit	Test	Degree of	Expansive	according	to:
DB	Sample	LL	PL	PI	Holtz & Gibbs	Chen	Chen	Raman
	(m)	(%)	(%)	(%)	(1956)	(1965)	(1988)	(1967)
1	1.50 - 2.00	73.70	47.08	26.62	High	Very High	High	Very High
	11.50 - 12.00	62.50	42.53	19.97	High	Very High	Medium	Medium

	13.50 - 14.00	63.40	37.71	25.69	High	Very High	High	Very High
2	1.50 - 2.00	76.10	40.32	35.78	Very High	Very High	Very High	Very High
	5.50 – 6.00	74.50	37.03	37.47	Very High	Very High	Very High	Very High
3	1.50 – 2.00	70.00	38.16	31.84	High	Very High	High	High
	7.50 – 8.00	73.00	34.77	38.23	Very High	Very High	Very High	Very High
	9.50 – 10.00	80.20	37.09	43.11	Very High	Very High	Very High	Very High

Longer slope gradient conditions than the undersized thickness may be considered that the slope of the slope is unlimited. Based on the above, in analyzing the stability of the slopes is used the method proposed by **Duncan, *et. al.* (1987**).

Data from undisturbed samples were obtained from the field (Figure 2) and used the slope of 21° according to slope measurement and it was assumed that clay thickness of 5 m and 4 m.

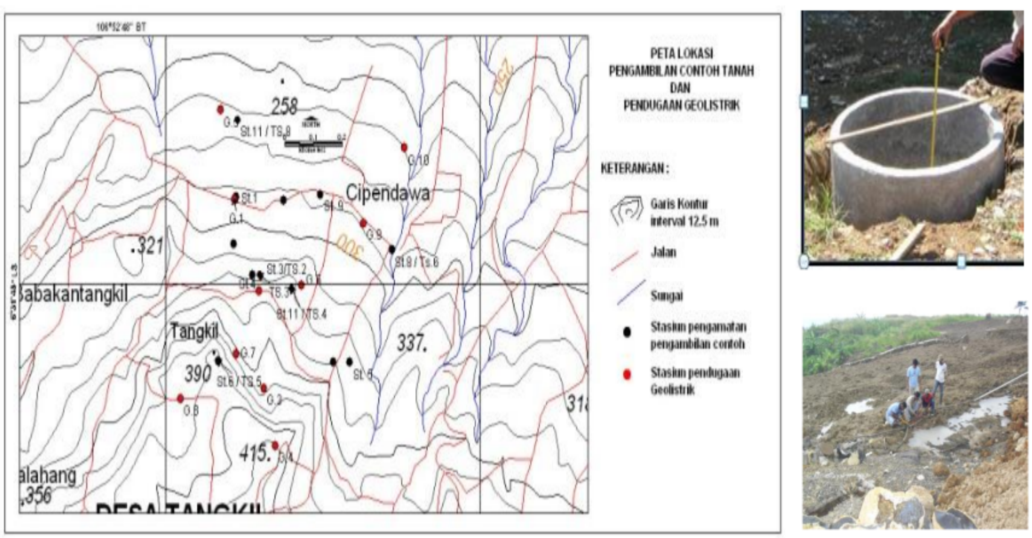


Figure 2: Land location sampling map amd existing soil with existing soil with well foundation solutions to overcome sliding

Stability of slopes for areas in the Southern area dominated by old volcanic rocks riding on top of clay of Jatiluhur Formation have rock layers slope of N45° E/14° (Measurement at)

$$FS_2 = \frac{\sum \{[cb + (W - ub) \tan \Phi] \, 1/M(\theta)\}}{\sum W \sin\theta} \quad (1)$$

and

$$M(\theta) = \cos\theta \left(1 + \frac{\text{Tan} \tan\Phi}{FS_1}\right) \quad (2)$$

W = weight
θ = slope of land
Φ = soil shear angle
cb = soil cohesion value
ub = pore pressure

From the calculation of the slope stability can be given the following suggestions:

1. In the Jatiluhur Formation, clay which has a position of rock layers parallel to the slope of the ground surface is not safe for building construction, especially during the rainy season. This is because the calculations generally have a security grade < 1.75 and has a clay layer thickness > 5 m.
2. On the second terrace or Southern of the Observation Station 4 Cliffs is quite safe because it has a security grade of 1.74 and has a field of soil layer opposite to the slope of the surface.
3. In the Southernmost slope is quite safe when the slope angle is supposed to have a slope of 25°.
4. Behind the slopes at Observation Station 4, it is quite safe to build the building construction with the border on the sidewalk side of more than 5 m.
5. On the Southernmost slope up to a height of 30 m escaping if it is done by passing through the Cliffs to a slope of 25°.
6. Building construction can be built at the top of the hill only needs to be made a border from the Cliffs.
7. In the East, the spread of clay extends to the East side (Observation Station 5) and until no landslides have also occurred at the small tilt of the slope.
8. Lightweight/1st 1st-floor construction can be built on the North side by fixing the foundation and spreading out new limestone land filled with red soil. Heavy buildings or more than one floor, it is likely to collapse because it is prone to landslides and damage with the very expansive nature of clay.

Three types of technical stabilization properties are chemical stabilization, physical stabilization, and mechanical stabilization (Ingles and Metcalf, 1972) with a tilt of 45-50°, limited cost, and narrow land. There is almost no suitable land in the countryside so the structure of buildings, infrastructure is easy to move and landslides because the soil is very fertile so that it is necessary to provide the right solution, namely:

1. Narrow land contours on the site 11 of office buildings, classrooms and houses, garages and ceremonial courts, tennis courts, lake utilization contours, site plan symmetry, the effect of active earth pressure and water pressure must be partially channeled so that the force received by the structure is reduced due to water pressure distributed partially through the drainage. Buildings must be isolated from active soil pressure and water pressure.
2. The natural balance is maintained with natural conditions or contours that do not change, the distance and height of the land contour are relatively small so that the active force is small.
3. Surface water or groundwater is channeled through sub-drains created at the bottom of infrastructure and housing so as not to compress the structure and not damage the structure. Energy loss due to subdrain is:

$$L.v2 / (D.2g) \qquad (3)$$

L = length of sub drain
D = sub-drain diameter, V = flow velocity, g = gravity
The structure must be strong, stable, and rigid if it experiences together with a decrease or deflection of the building so that it does not tilt or bend by using strong structural material, long life, friendly environment.
4. Equipment and tools are easy to be used but they can prevent landslides capability.
5. Two-floor buildings, garages, or one-floor buildings use circular pipe concrete. Others use piles, but at some piling, points hit chunks of stone which must be replaced with round pipe concrete.
Narrow/limited land is used in institutions such as Figure 5, hilly, lowlands with many buildings and infrastructure must be careful especially on land that is prone to landslides.

a. Existing Land | b. Survey Author | c. Crack 10 cm after clearing

Figure 3 Survey of existing land and crack soil

Figure 4 Site Plan of government institution consists of 11 building offices, class

Technical Considerations, including:

1. Chemicals should not be used, due to no environmentally friendly, expensive considerations, and the reinforcement of retaining walls that receive active soil pressure.
   The circular pipe concrete foundation also supports the load on it. The capacity carrying shallow drilled foundation = A.σ + A skin
2. Equipment mobilization is carried out to minimize costs and for beauty, comfort, and speed of work.
3. Sub drains use easy materials, namely concrete circular pipes or PVC pipes so that buildings or infrastructure are not pushed by water mixed with soil.
4. Soil subsidence together is an upper and lower unitary structure.

   EI / L = stiffness (5)
   I = moment of inertia
   E = Modulus of Elasticity,
   L = span of structure.
   So that the soil subsidence is not different, the upper and lower structures are combined so that the stiffness is large.

5. To use soil retaining walls with their counterpart to overcome the horizontal forces that must be retained. In principle, the remaining portion of the horizontal force must be retained. The horizontal force of active soil pressure, groundwater pressure, and surface wais ter due to the differences between the front and the rear of the building.
6. Equipment used is by existing land, the land is very steep so it should be trimmed a bit for the tool holder.
7. The use of appropriate structures to the style is retained but must be easy.

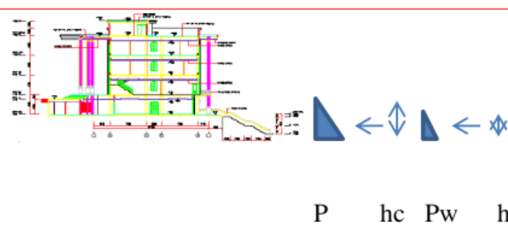
The analysis must meet the 7 (seven) provisions above and keep the contours stable. Infrastructure, buildings, and under the building were in sub-water channels so that water did not push the building. Shallow drill or post tied together; floor slabs become a unified structure if there was a single unit so that it was not damaged. The lower part of the lowest contour is given a concrete counterpart to hold the horizontal force. Reinforcement structures are provided at the bottom of the road. This applies to all countries where the soil was prone to landslides and the site contours from hills to lowlands or midlands.
The solution in the project must be easy to understand and easy to implement so that all parties can construct it properly. Seven solutions:

1. All buildings and infrastructure are only partially the same in one location, it is necessary to determine the front point and position of the equipment which must be small enough to help cut and fill with minimal volume.
2. The water content of the soil must be maintained so that it does not expand, it is necessary to install sub-drains on buildings and infrastructure. It is easy to get PVC pipe or concrete pipe.
   Water discharge pressure:
   Q = VA (6)
   or water pressure ɣair.H (7)

   From the contour of soil level must flow in the sub-drainage building, the soil at the slope level must be able to flow in the sub-drain, sub-channel to reduce fatigue by draining surface water to the calculated drainage capacity thereby reducing the structure. Reduces fatigue and cost-effectiveness as the water surface flows without being pushed.

3. Without the use of chemicals and lime because of the large location that requires high cost.
4. The foundation adapts to the applied load, heavy loads are used by pile foundations, while for two-floor and one-floor buildings, housing, garages, and roads, concrete circle pipes are attached to the beams and floor slabs.
5. The contour is maintained by the existing contour, so that the existing groundwater, in addition to the cost of low cut fill, active soil pressure is not strong, and surface water is collected in the lake to be used for watering plants, cleaning cars and daily cleaning. Technically, the function of the lake is to dampen the strength of the outgoing water flow so that the current does not flow where in a location where its level is much lower.
6. Piling equipment does not the uselementation of a hammer, but the pressure to penetrate the stone, if the stone hits the ground then the pile must go into the ground 12 m. If it reaches the end of the pedestal, then a shallow foundation drill is added to the side.
7. After distribution, strong and dangerous horizontal forces must be retained with counterforts, retaining walls by utilizing stairs and floor plate unity with tie beams and pile caps.

a. Retaining wall implementation photo



b. Water force calculation, soil pressure,

Figure 5. Counterfort, retaining wall by utilizing stairs and floor plate unity with tie beam and pile cap

Horizontal force due to active soil pressure and water pressure. [**Fang H, Y (2013)**]

$$Ka = \tan^2 (45 - Ø) \qquad (8)$$
$$P = 1/2 \times Ka \times \gamma \times (h_c)^2 \qquad (9)$$
$$Pw = \gamma_w h^2/2 \qquad (10)$$
$$P\ total = P + Pw \qquad (11)$$

P = active force

Ka = coefficient of active soil pressure

Ø = internal friction angle of soil shear resistance angle

γ = weight of soil volume

H = height in general = hydraulic head

hc = the vertical distance from the ground surface, cohesive soil to zero stress point

γ_w = unit weight of water

It has to be careful in building infrastructure and buildings with each other in a narrow area can cause damage. The solution must not be expensive, easy to build, the contours of the land are fixed, and groundwater must be channeled.
Software places, for example, plaxis, can be used to calculate soil retaining structures and water pressure. This application includes the type of soil according to its real value, as well as the water level.
Further research needs to be carried out on expansive soils with contour soils (hills to lowlands), every work both buildings and infrastructure must maintain the existing conditions so that there is no new balance that can lead to disaster.

5. Conclusion

The solution provided by the author to, supervisors, building tools, and infrastructure must be easy to understand and easy to be done. The lower and upper structures are calculated as the actual strength. Part of the horizontal load must be channeled, partly held by the building structure so that the building structure were light enough to withstand horizontal forces. Moreover, structures can serve according to the building's lifetime. If all the working loads are accepted, the building structure is expensive and its service life is short. The building has been isolated from stone or concrete retaining wall installed with counterforts in the shear potential area so that it does not move and wedge to withstand horizontal forces.
The novelty is that the buildings and infrastructure are not cracked, tilted and the cost of the structure is not expensive because the structure only receives the residual force since some water pressure has been channeled horizontally, the water force is channeled through the drain pipe so that the groundwater pressure is close to zero. The solution applies to all countries, easy construction and easy understanding for field engineers where the soil is prone to landslides, land conditions with different levels and existing land conditions must be maintained.
Continuous horizontal force, in addition to the earthquake force at any time that can cause damage and destruction of the structure of buildings, becomes a solution focus. The contour difference causes the building to slide easily due to the difference in elevation contours, the type of water from the hills plus rainwater with an average annual rainfall of 1534 mm. Together with the soil pressing the building with high pressure causes the building is cracked, tilted, and collapsed even though there is no earthquake. Vertical style of building load according to Indonesia Standard Code. Load force of vertical building according to Indonesian Standard Code.
The solution should be easy to build, cheap, take care of soil contour, and groundwater must be channeled.
The balance of nature is maintained by taking care of the natural terracing, otherwise, it adds to the overall beauty of the area.
Through in-depth, measurable, detailed analysis, the results of hydrogeology, geology, soil investigations, and sand surveys are required for design on expansive soils. In addition, it is also necessary to analyze the community environment, availability of costs, and the natural environment.

6. Acknowledgments:

The authors would like to thank the friends of consulates and contractors at the defense ministry building in Jakarta. Officials, friends consultants, and contractors provide and collect data and information during the construction of infrastructure and building that daily performs, control, test and controls the tools, materials, labor, and environment so that the building stands firmly with zero accidents. Thank you to all the defense ministry government officials and friends in the ministry of defense. In addition, the source of data and references is hardcopy secondary data, the internet as the source of my manuscript.

7. Conflicting interests

There had been no conflicting interests. Stakeholders appeared to be happy that the the building met the requirements of strength, stability and stiffness. The operation of the building is now safe and comfortable, calming the users.

8. Funding

The author receives professional services, travel and accommodation facilities from the company, facilitating the cost of field testing and laboratory tests. These costs have already been agreed upon in advance

9. The data statements you have chosen in the submission questions are:

a. Some or all data, models, or codes that support the findings of this study are available from the corresponding author upon reasonable request;

This is due to the existence of transverse fractures that lead North-Northwest to South-Southeast.

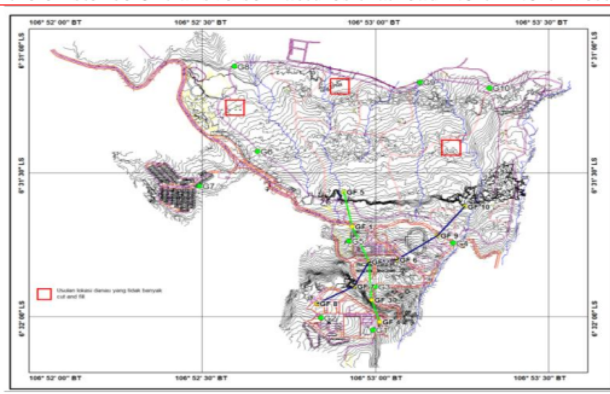


Fig.1. Location TS 1 until TS 8

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3	TS.3	14,95	4	3,7375	Ca – Montmorillonite

4	TS.4	35,32	29	1,217931	Illite
5	TS.5	55,14	59	0,9345763	Illite
6	TS.6	52	53	0,9811321	Illite
7	TS.7	35,39	43	0,8230233	Kaolinite
8	TS. 8	60,81	48	1,266875	Illite

Table 2 Plasticity and shrinkage index underlies the Expansive Soil Classification Index

				Data based on index tests				
CC *1	PI*1	PI *2 (1988)	PI*3	SI(%)*3	SL *1	PE*1	PE *2	DOE
>28	>35	>35	>32	>40	<11	>30	>10	Very.High
20-31	25-41	20-55	23-32	30-40	7-12	20-30	3-10	High
13-23	15-28	10-35	12-23	15-30	10-16	10-20	1-5	Medium
<15	<18	0-15	<12	<15	>15	<10	<1	Low

Description:

f. SL = Shrinkage Limit
g. SI = Shrinkage Index
h. PI = Plasticity Index
i. DOE = Degree of Expansion
j. CC = Colloid Content (% minus 0.0001 mm)

c. All data, models, and code generated or used during the study appear in the submitted article;

Table 3. Classification of expansive soil, location in the Tangkil villages Kec. Citeureup. Sentul is based on Atterberg Limit Test

No	Depth	Atterberg	Limit	Test	Degree of	expansive	according	to:
DB	Sample	LL	PL	PI	Holtz & Gibbs	Chen	Chen	Raman
	(m)	(%)	(%)	(%)	(1956)	(1965)	(1988)	(1967)
1	1.50 - 2.00	73.70	47.08	26.62	High	Very High	High	Very High
	11.50 - 12.00	62.50	42.53	19.97	High	Very High	Medium	Medium
	13.50 - 14.00	63.40	37.71	25.69	High	Very High	High	Very High
2	1.50 - 2.00	76.10	40.32	35.78	Very High	Very High	Very High	Very High
	5.50 – 6.00	74.50	37.03	37.47	Very High	Very High	Very High	Very High
3	1.50 – 2.00	70.00	38.16	31.84	High	Very High	High	High
	7.50 – 8.00	73.00	34.77	38.23	Very High	Very High	Very High	Very High
	9.50 – 10.00	80.20	37.09	43.11	Very High	Very	Very	Very

						High	High	High

Data from undisturbed samples were obtained from the field (Figure 3) and used the slope of 21^o according to slope measurement and assumed clay soil thickness of 5 m and 4 m.

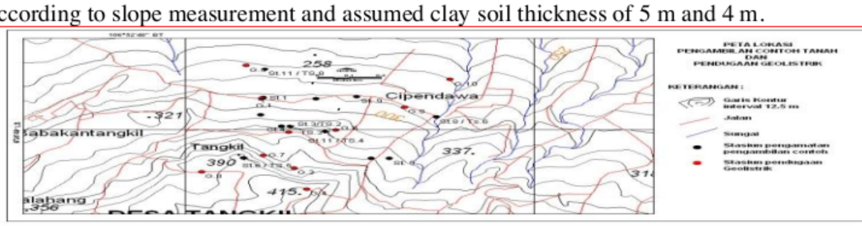

Figure 2: Land location sampling map

Stability of slopes for areas in the Southern part dominated by old volcanic rocks riding on top of clay of Jatiluhur Formation have rock layers slope of N45^o E/14^o (Measurement at)

$$FS_2 = \frac{\sum \{[cb + (W - ub) \tan \Phi] \; 1/M(\theta)\}}{\sum W \sin\theta} \quad (1)$$

and

$$M(\theta) = \cos\theta \left(1 + \frac{\text{Tan} \tan\Phi}{FS_1}\right) \quad (2)$$

W = weight
θ = slope of soil
Φ = soil shear angle
cb = soil cohesion value
ub = pore pressure
Narrow/limited land is used in institutions such as Figure 5. Hilly, lowland with many buildings and infrastructure must be careful, especially on land that is easy to slide

a. Existing Land	b. Survey Author	c. Crack 10 cm after clearing

Figure 3 Survey of existing land and crack soil

Figure 4 Site Plan of government institution consists of 11 building offices, class

	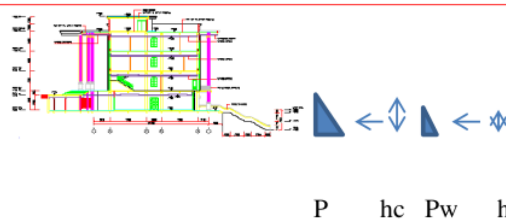
d. option of retaining wall photo	e. A water forces calculation, soil pressure,

Figure 5. Counterfort, retaining wall by utilizing stairs and floor plate unity with tie beam and pile cap

Horizontal force due to active soil pressure and water pressure. [**Fang H, Y (2013)**]

$Ka = \tan^2(45 - Ø)$ (8)
$P = ½ \times Ka \times Ɣ \times (h_c)^2$ (9)
$Pw = Ɣ_w h^2/2$ (10)
$P\ total = P + Pw$ (11)
P = active force
Ka = coefficient of active soil pressure
Ø = angle of internal friction of soil shear resistance angle
Ɣ = weight of soil volume
H = height in general = hydraulic head
hc = vertical distance from the ground surface of cohesive soil to a point of zero stress
w = unit weight of water

f. Some or all of the data, models, or codes created or used during the study are available in online repositories by the funders' data retention policies.

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