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Enhance Land Support Layer Road Pavement Subgrade Soil Plant Stability Based on Geotextile

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Abstract— *At the stage of a construction work one of the main problems in soft soil is the large land decline. The large decrease is due to the decrease in soil. The condition of poor base soil in the form of clay soil needs to be done to improve the basic soil to be able to support the construction load. One method used as land improvement is by geotextiles. This paper described type of geotextile used in the construction of the Medan-Kualanamu-Tebing Tinggi toll road project, Parbarakan-Lubuk Pakam Sta.42 + 750-Sta.47 + 600 is a geotextile PP woven polypropylene. The geotextile type uses non woven geotextile while the study is geotextile polypropylene woven, Non woven tensile strength 20 kN / m required 1 layer of geotextile while tensile strength Polypropylene woven 30 kN / m required 2 layers of geotextile. From these calculations can be concluded that the use of geotextiles can be used as one of the repair and retrofitting*.

Keywords— *Geotextile; Stability against soil degradation; Internal Stability*.

I. Introduction

As the development, forms of construction are increasingly diverse. To build a type of construction that requires a fairly wide area, for example the construction of highways going up and down too steep like a bumpy can endanger motorized vehicles because of the visibility of the driver of the vehicle. But in the field, ground level is not always the same. Therefore, a heap is needed to equalize the elevation of the land.

With the embankment on the existing road body reaching 2.40 m, the existing soil is very soft to the soil layer, high ground water level and the structure of the embankment to be built on it is very vital, then the pile work must be prepared and implemented carefully so as not to cause technical problems later on. By observing these conditions and so that it can be believed that the embankment to be built can be in accordance with the planning targets for current field conditions. The purpose of this study is to prepare an initial technical material for the implementation of access road pile work to anticipate problems that may occur during construction and when the toll road operates.

Aims of the study show that there are several technical problems in toll road locations, namely the discovery of soft soil which is thick enough, is considered necessary to be discussed so that it does not have a bad impact on project implementation. For that reason, this technical study seeks to identify technical problems and propose them for discussion so that when the implementation of the problem is known and can be reduced to a maximum impact. To overcome the decrease due to embankment on soft soil there are various ways to overcome it. In general, the methods used to improve soft soil conditions are four ways, namely physical, chemical, hydraulic or reinforced materials. The geotextile method is one of the technology methods of materials used with polymer base materials which are very useful in solving problems related to soil stability, increasing the strength of soil stability and preventing uneven decline.

A study is to evaluate the results of calculations obtained in the field of Medan-Kualanamu- Tebing Tinggi toll road work by calculating geotextiles to improve the stability of subgrade layer soil with polypropylene woven geotextiles. The purpose is to compare the results of the author's design with the results in the field to improve the stability of subgrade layer soil on the Medan-Kualanamu-Tebing Tinggi Toll Road works.

Evaluate and compare the stability of subgrade using geotextile with polypropylene woven geotextile. Can this geotextile improve soil stability. What are the results of calculations to obtain efficient use of geotextiles. In accordance with the above problems, the limitation of the problem taken by the author is not to discuss calculating CBR, the results of soil monitoring data, boring data to avoid data processing deviations that are too far away and so the discussion is not too broad and in accordance with data

In general technical sense, land is defined as material consisting of aggregates (granules) of solid materials that are not cemented (chemically bound) to each other and from decaying organic materials (which are solid particles) accompanied by liquid and gas that fills the empty spaces between these solid particles (Das, 1988). Whereas in mechanics the soil referred to as land is all natural deposits associated with civil engineering, except for fixed rock. These natural deposits include all materials from clay soil to boulder. The soil is useful as a building material in various types of civil engineering work, in addition the land also functions as a support for the foundation of the building.

Emphasizing that from a technical point of view, these lands can be classified into the following basic types: Gravel (Gravel), Sand (Sand), Silt (Silt), Organic Clay (Clay). As mentioned earlier, the term land in Soil Mechanics is that which covers clay (clay) to rock (gravel).

Some types of soil can be explained as follows: Loose sand is a low density sand deposit. If the foundation of the machine is on loose sand, the vibration of the machine will compress it, causing a large decrease. The earthquake load will cause the melting of sand if the sand is saturated and will cause a large decrease. Soil (loess) is a composite that is relatively uniform, silty soil in the wind. This loess has a high vertical permeability, but its horizontal permeability is low. The soil becomes very compressible when saturated. If a

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building is above the loess ground, to prevent a large decrease after the building is finished, before construction starts this soil layer is moistened first so that there is a decrease before construction begins. Normal consolidated clay (clay consolidated) is clay that never exerts greater pressure than the current pressure, this soil is generally very compressible, has a low bearing capacity and low permeability. Because of its high compressibility, this land is unable to support buildings with shallow foundations. So the pile foundation is needed to continue the building load to the deeper soil layers which have a higher carrying capacity or use a plate foundation where the weight of the soil excavated for the basement is the same as the weight of the building. Bentonite is a clay that has high palsyticity resulting from the decomposition of volcanic ash.

This land is very expansive which expands large enough if the composition is large. This causes problems on foundations, sidewalks and others if it is above this soil layer because if there is a change in the season the soil water content will change. Peat is a fibrous semi- weathered organic material. Peat has very high pore numbers and is very compressible. If the building is on peat soil, the decline will be very large.

Geosyntheticsconsist of two syllables, Geo which means land and synthetic means imitation. So geosynthetics are synthetic materials or materials that are not natural materials used in the soil environment. Various types of geosynthetics have been used in Indonesia since the 1980s. This synthetic material can be in the form of materials derived from polymerization of the results of chemical industries (petroleum), steel materials, cement, synthetic fibers, fabrics and others. In general, this geosynthetic can be said to be the original or artificial fibers used in works related to soil, rocks or soil / artificial environments, but the meaning that is now developing,

II. LITERATUR REVIEW

Geosynthetics is synthetic material in the form of woven synthetic fibers. non-woven or other forms (mat, web etc.) used in earthworks. With properties that are resistant to chemical compounds, weathering, wear, ultra violet rays and micro organisms. The main polymers used for the manufacture of geosynthetics are polyester (PS), Polyamide (PM), Polypropylene (PP) and Polyethylene (PE). So the geosynthetic term is generally defined as a polymer material applied to the soil. (Suryalelono, 1988).

Geotextile is a sheet material made from polymeric textile material, which is water-escaped, which can be non-woven, knitted or woven which is used in contact with soil / stone and / or other geotechnical material inside civil engineering applications. Materials used for geosynthetics, mainly from the plastic industry, namely polymers, although sometimes rubber, fiberglass and other materials are also used. In the market, geosynthetics consist of various geometric shapes and different polymer compositions to meet the many needs. All geotextiles, generally made from strong, durable materials, whose basic ingredients are resistant to chemical reactions, the influence of weather and the aging process.

Usually this geotextile is used to make the land more stable. The other uses, geotextiles are often used also to strengthen soft soil, hold large loads, separate the protective layer, and increase the strength of landfills. The advantage of this method is that the process takes a relatively short time and the costs that must be incurred are cheaper than conventional landfilling. Some functions of geotextiles include soft soil reinforcement, for civil engineering construction that has a long planned life and supports large loads such as railroads and retaining walls, as separation, filtering, drainage and as a protective layer. Geotextiles are generally shaped like a fabric with a width of 2 to 5 meters, and a length of between 50 to 200 meters, packaged in roller or other forms.

One geosynthetic material that is widely used in earthworks is geotextile. Geotextiles are water-escaped materials or factory-made textile materials made from synthetic materials such as polypropylene (± 92%), polyester (± 5%), polymide (± 2%), polyethylene (± 1%). Polylene and polypropylene are polyolefins which have a density of less than 1000 kg / m3. As explained that geotextiles are materials laid on the ground, the function of geotextiles in subgrade repair business is as follows: Separation The use of geotextiles can separate the landfill and subgrade below. If you do not use embankment material geotextiles will drop down due to due to the burden from above and also due to the weight of the heap itself. To overcome this problem, geotextiles are used as a dividing benefit: Accelerate the achievement of landfill voltage into subgrade. Prevent embankment soil from falling into the subgrade so that the volume of embankment does not change. Compaction is easier. Filtration Related to the filtration function, the geotextile serves as a filter to prevent the entry of water and fine grains from the subgrade into the base layer of the embankment. At the same time, geotextiles must also be able to hold back embankment so that the embankment material does not join the flow, so that the stacking material and subgrade material can be maintained.

III. RESEARCH METHODS

Data collection methods in this study are supported by data obtained from various sources, including: Literature study, data collection from books, papers, journals and lecture notes related to the study, primary data, is the main data needed in this study . Primary data in the form of planning data and plan drawings obtained from PT. Waskita Karya, secondary data, is the supporting data needed in the preparation of this thesis. This secondary data is in the form of research objectives in the project activities of PT. Waskita Karya, holds questions and answers with relevant agencies and parties who understand thist paper.

IV. RESULT AND DISCUSSION

Geotextile Calculation in the Field On the subgrade location the road body is found to have thick, undrained, fine-grained soil layers. The thickness of this soil layer varies from 7.80 m to 11.60 m. The consistency of the soil layer from soft to medium and compressible. The type of soil found consists of clay with medium to high plasticity, silt with low to high plasticity and silty sand (CH, CL, MH, ML, and SM).

In this compressible soil layer is found a layer of sand or sand that is drained. In general, this layer of sand density is

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found from medium to dense conditions and is very dense according to the increase in depth. Soil investigations have been carried out on the trajectory of the Sta. Toll road. 42 + 750 s / d Sta. 43 + 400 to evaluate landfill conditions in the form of boring, SPT, uninterrupted soil sampling and mild Sondir. The soil investigation for machine drills was carried out in 3 (three) points, namely BM-10 Sta. 42 + 825, BM-11 Sta. 42 + 900 and BM-12 Sta. 42 + 900. Tests that have been carried out at this location are soil identification.

Although this drilling is not carried out on the access road, the data can still be used to evaluate the embankment on the access road. This data can be used as a comparison when evaluating embankment on the access road where the soil investigation is carried out by means of sondir. Based on the results of sondir it is known that the surface soil layer is generally dominated by clay soil layers, silty clay or sandy clay. The thickness of the undrained soil layer at the location of the access road varies between 7.80 m to 11.60 m. At depths greater than 7.80 m to 11.60 found a layer of soil sand or sand soil with medium to solid density (the minimum sondir value ranges from 40 kg / Cm 2-100 kg / Cm2). Groundwater at the time of investigation The soil also varies from 1.00 m to 2.40 m below ground level. The thickness of soft soil for the change of material determined based on the resistance value of conus penetration qc <10 kg / Cm2 also varies between 0.8 m to 2.4 m.

It is expected that at the time of hoarding the road, the soft soil lens layer can be penetrated and compacted by embankment load. Imposing that is calculated to burden the original land is the burden of road piles, pavement loads and traffic loads. In this case the earthquake load was not taken into account because the embankment was not too high and the embankment slope geometry, according to the design, was quite good.

The burden of pile road is the weight of landfill which is the multiplication between the weight of the landfill and the height of the embankment. This pile load will be different for each segment depending on the original ground elevation and subgrade elevation.

The pavement load is the weight of each planned Kaku (rigid) pavement component, consisting of:

Base A: 15 cm

Lean Concrete (LC) : 10 cm Rigid Pavement : 27 cm

Traffic load calculated to weigh on soft soil is 1.5 tons / m2.

Preloading load is as high as embankment land (load safety factor =1.1): 1,1 x (pavement load / g + traffic load / g)

The total pavement load and traffic load are also referred to as the preloading load calculated at 2.88 tons / m2. For the design process of loading native land, it is always calculated as an even load and can be represented by landfill loads. By taking the weight of the landfill, = 1.60 tons / m3 and obtained preloading pile as high as 1.80 m. For this geotechnical study, two sondir points were observed, namely on S-5, Sta.1 + 450 and for the location of S-8, Sta. 1 + 900. The magnitude of the simulated load is 2 alternatives, namely: Based on the height of the embankment material load, the embankment plan elevation is reduced by the existing original land elevation. Modeled as high as 2.4 m for locations on S-5, Sta.1 + 450 and 0.71 m for the location of the S-8 Sta. 1 + 900. Based on the load height of the embankment material (2.40 m for S-5 and 0.71 m for S-8), the preloading load height is 1.80 m. Calculation of Polypropylene.

Woven Geotextiles, UW - 200

- Pile load
  qtimb = 0.86 t / m²
- Pavement load qperkerasan Base A = 15 cm
- Lean Concrete (LC) = 10 cm Rigid Pavement = 27 cm
- Traffic load
- qtraffic = 1.5 t / m² + qtotal = 2.88 t / m²

TABLE 1. Landfill and Pavement Land Data

Description	Value	Information
Sliding angle of sandy soil (ø)	27°	Tabel 4.1
cohesion (Cu)	10 kN/m^2	Material
t embankment	20 kN/m^3	Material
Old pavement thickness	0,75 m	DPU Balai
High embankment permission	0,35 m	Pers (2.13)
pavement q Load	3,3 kN/m^2	PPI tahun 1983

TABLE 2. Identification of Subgrade Data and Road Widening

Description	Value	Information
Old + new pavement width (B)	14 m	Planning
New road Widening	3,5 m	Planning
Slope of the road slope	2H : 1V	DPU Balai
Subgrade cohesion (cu)	12,6 Kpa	DPU Balai
Ground shear angle ( )	3,1˚	DPU Balai
sat subgrade	16,3	DPU Balai
Thick soft soil layer (h)Source :	5 m	DPU Balai Planning Data

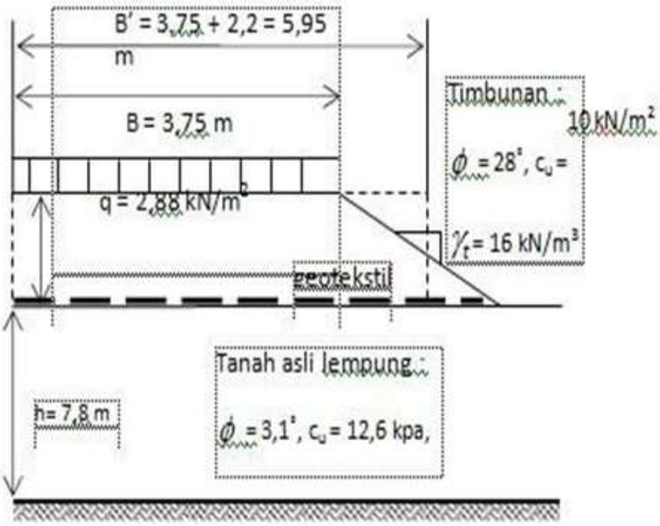


Figure 1. Specifications of Landfill and Native Land for Stability Calculation Analysis

The tensile force acting on the top surface of the reinforcement (T1) is assumed to be equal to the active ground pressure behind the AB plane (Figure), so Equation is used:

T1 = Pa1 = 0.5H2 Ka

Ka = tg2 (45-ø / 2)

= Tg2 (45-28 / 2)

= 0.36
T1 = Pa1 = 0,5qH2 Ka
= 0.5. 2.88. 1,102. 16. 0.36 = 10.04 kN / m

So the need for geotextile tensile strength is equal to T1 = Pa1 = 10.04 kN / m

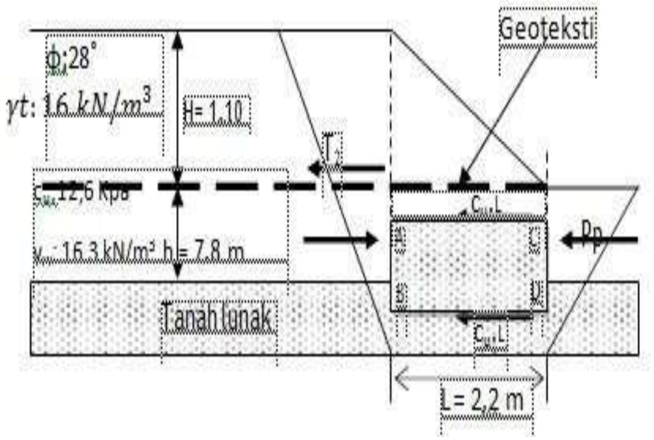
The safe factor for slipping slopes against geotextile reinforcement (Figure 2) uses equation:

SF = Pg / Pa1 = L (0.5 H γ) tgδ / (0.5 Ka H² γ) = (L tgδ) / (Ka H)
= (2.2. (0.8 x tg 28°)) / (0.36. 1.10)
= 1.51> 1.50 (qualifies)

The safe factor for breaking reinforcement by drag and embankment slips on the foundation soil (Figure 2) using equation:

SF = (2 (Lca + T1)) / (Ka γ H²)
= (2. (2.2 .10 + 10.04)) / (0.36 .16 .1.10²)
= 9,19> 1,50 (qualifies)

Foundation stability



Figures 2. Analysis of foundation stability

To calculate the stability of the foundation check against the presence of lateral pressures

Active soilpressure Pa = Pw + Pal + Pqa
= 1/2 γw h² + 1/2 γh²Ka-2cu h √ka + qs1 h Ka
= 1 / (2) .9,18 .1,1² + 1/2 6,49 .1,1².0,36-2 .12,6 .1,1√0,36 + 2. 16. 0.36
= 5.55 + 1.41 - 16.63 + 11.52 = 1.85 kN / m
Kp = tg2 (45 + ø / 2)
= tg2 (45 + 28/2)
= 2.76

Passive soil pressure Pp = Pw + Ppl + Pqp
= 1/2 γw h² + 1/2 γh²Kp-2cu h √kp + qs2 h Kp
= 1 / (2) .9,18 .1,1² + 1/2 6,49 .1,1².2,76 + 2,12,6,1,1√2,76 + 0,2.76
= 5.55 + 10.83 + 46.05 + 0
= 62.43 kN / m

To check for Lateral squeeze (Lateral squeezing), the equation is used:

Pp + 2cu. L> Pa
62.43+ 2. 12.6. 2.2 = 117.87> Pa = 1.85 kN / m (so, there is no lateral soil foundation)

A safe factor against lateral forces (equation):

SF = 2Cu / (γ htgβ) + (4.14 Cu) / Hγ
= (2,12,6)/(16,7,8. Tg14°)+(4,14.12,6)/(1,10.16)=3,77>1,50 (qualifies)

Tensile force acting on geotextile reinforcement (equation):

T2 = cuL
= 12.6. 1,2
= 15.12 kN / m

Because geotextiles must withstand the lateral distribution of embankments and foundation soil movements, the tensile forces acting on geotextiles are used in equation:

Ttotal = T1 + T2
= 10.04 + 15.12 = 25.16 kN / m

For the ultimate geotextile tensile strength used equation:

Ttotal = Tu (1 / (RFiD x RFCR x RFD))
Tu = (1,1 x 2 x 1,1) = 2,4 x 25,16 = 60,38 kN / m

So, the minimum geotextile maximum tensile strength is needed: Tu = 60.38 kN / m

Based on the geotextile review of the 3 embankment stability, the geotextile ultimate tensile strength is 60.38 kN / m, so we use woven geotextiles with the following specifications:

Type of geotextile: Polypropylene Woven Geotextile
Geotextile type: UW - 200 Weight: 200 g / m2 Color: Black
Tensile strength: 30 kN / m Serobot tensile strength: 1600 N

So for the need for tensile strength of 60.38 kN / m, 2 layers of UW-200 geotextile type are used with a tensile strength of 30 kN / m layer. Provided that the security factor is minimal or greater than 1.4 SF ≥ 1.4 (PT. Teknindo Geosistem Unggul), then:

So, SF = ((3 x tensile strength)) / (tensile strength needs)
(3 x 30kN / m) / (60.36kN / m) = 1.5> 1.4
(qualifies)

So the UW-200 type geotextile with a tensile strength of 30 kN / m already meets the requirements.

Note: The geotextile reinforcement installed at the base of the embankment used is more than one layer, so that between the geotextile reinforcement must contain a layer of granular material 20-30 cm thick, or the geotextile layers must be mechanically connected to one another (sewn).

V. CONCLUSION

The pavement load is the weight of each planned Kaku (rigid) pavement component, consisting of: Base A: 15 cm, Lean Concrete (LC): 10 cm Rigid Pavement: 27 cm Traffic load calculated to weigh on soft soil is 1.5 tons / m2. The type of geotextile in the field uses Non woven geotextiles, while this study uses polypropylene woven geotextiles. 20 kN / m Non woven tensile strength required 1 layer of geotextile while 30 kN / m Polypropylene woven tensile strength required 2 layers of geotextile. In the research location, heap reinforcement cannot be done directly, because at that location has a high soil moisture content so that it requires using geotextile as embankment reinforcement. Geotextile material as a separator is needed so that when the access road filling work does not occur, fine-grained subgrade materials are not mixed with coarse-grained embankment material. Finally, the stabilization process is needed in dealing with unfavorable land conditions, especially if the construction of the land is to be carried out. As explained that the stabilization process is very important especially to maintain the balance of soil elements to be solid and can be used for good and decent development.

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