SHEET PILE CONSTRUCTION DESIGN AS AN ALTERNATIVE TREATMENT FOR LANDSLIDE ON THE CITY BOUNDARY'S ROADS SECTIONS OF TANAH GROGOT-LOLO KUARO, TANAH GROGOT DISTRICT, PASER REGENCY, TANA PASER

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ABSTRACT

In Tanah Grogot district, precisely on the KM 6 road which is the city boundary roads of Tanah Grogot City-Lolo Kuaro it has an important role as the only access for road users. Because at the side of the roads does not have a drainage channel, resulting in water overflowing and the seepage flowed on the surface, causing a landslide. The length of the landslides is 50 meters, with a width of 5.5 meters and the highest height is 9.6 meters. The result of this landslide is very disturbing for the road users. The delivery of goods and services can not be accommodated properly. Therefore, it is expected that this path must be handled properly, so the road can be functioning again safely and comfortably. How to handle this problem is by making a design of retaining walls construction which is safe in form of sheet pile.

The planning for this anchored sheet pile begins with analyzing the secondary data in form of data sondir, laboratory data, and topographic measurement data. This then followed by the calculation of the forces acting on the sheet pile, the calculation of moments in the sheet pile, the calculation of the carrying capacity of the pile on the anchor, capacity calculations for the mast against a lateral load, and the slope stability analysis using GeoStudio2007 application. After that designing the sheet pile construction, tierod, the pile, planning the budget, and makes the Detail Engineering Design (DED).

From the planning, the profile of concrete sheet pile obtained is CCSP W-500-A-1000 with a total length of the sheet pile is 12.2 meters. On tierod using dimensions of 6.32 m long with a diameter of 5 cm. On the pile is using a steel pipe with a diameter of 40 cm which penetrated into 10 m depth. For the stability of the slope with the reinforcement of piles obtained SF = 5.5> 1.25, which can be said as safe.
Keywords: designing sheet pile, anchored sheet pile, steel pipe piles.

1. INTRODUCTION

Paser Regency is a district located in the southern most region of East Kalimantan province with its capital Tana Paser, geographically situated between 0 ° 45 '18.37 "- 2 °

27' 20.82" latitude and 115 ° 36 ' 14.5 "- 166 ° 57 '35.03" E, located at an altitude that ranges between 0-500 meters above sea level. The total area of Paser is 41603.94 km^2,consisting of 10 districts. Districts with the largest area in Paser District of Long Kali, Paser, with an area of 2385.39 sq km, while the district's total area is Tanah Grogot smallest measuring only 33.58 km^2.Hilly contours and slopes too shallow ground hard enough to be a characteristic of the Tanah Grogot District.

The objective of this scheme is to get a plaster construction are safe and meet the technical requirements, which include:

1. Designing construction plaster is safe and meets other technical provisions.
2. Getting the design of the form of the plans / DED.
3. Getting estimates Budget Plan.

Locations case study is in the plaster construction Roads City Limits Land Grogot-Lolo Kuaro located in the district of Tanah Grogot, Paser Regency, Tana Paser, East Kalimantan.

Figure 1. Case Studies Point Location Using *Google Earth*

Figure 2. Soil landslide

Figure 3. Variations in Altitude Soil landslide

Figure 4. Soil landslide Next to the Canyons

Figure 5. Land Landslide Width

Figure 6. The road Collapsed Due to Avalanche

Figure 7. Part Jalan Broken Due Avalanches

Avalanches occur on roads with rigid pavement (rigid *pavement)*,which resulted in the passage way be broken. Soil landslide 50-meter long, 9.6 meter high avalanche largest and width of 5.5 meters.

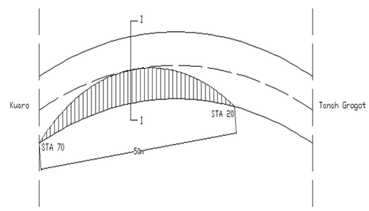

Figure 8. Sketch landslide Top View

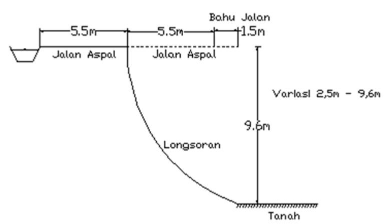

Figure 9. Sketch sliding Pieces II

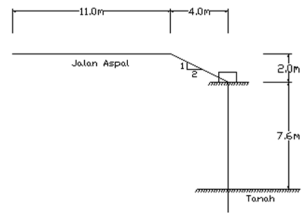

Figure 10. Using Landslide Handling

Sketch Sheet Pile

2. DATA DESIGN

2.1 Building Data

a. Sheet Pile's Wall

Type : Concrete/Steel Sheet Pile

b. Piles

Type : Steel Pipe Pile

Diameter : 0,4 m

Height : 10 m

c. Anchore

Type : ⧄ 400 x 400 mm

Long : 6 m

Tie rod : ∅ (4-6 cm)

2.2 DataMaterials

a. concrete

Quality concrete (f'c) = 25 MPa

concrete density (Wc) = 2,400 kg/m^3

b. steel

for steel reinforcement = U-30 (plain)

Voltage melting steel (fy) = U- = 300 Mpa

2.3 Data Research Soil

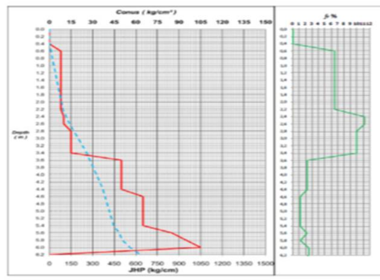

Figure 11. Test Results Graph Sondir Field

2.4 Budget Plan Data (RAB)

The calculation of the estimated Budget Plan (RAB) using Work Analysis Unit Price (AHSP) Paser 2016.

Table 1. Basic Price Materials Unit

No.	Nama Bahan	Satuan	Harga Satuan (Rp)
1	Timbunan Tanah	m^3	30.000
2	Kawat Las	Dos	172.500
3	Acytelin	Btl	400.000
4	Oksigen	Btl	215.000
5	Semen	Kg	2.344,05
6	Pasir	m^3	121.736,76
7	Agregat Kasar	m^3	582.680,05
8	Kayu Perancah	m^3	2.744.054,77
9	Paku	Kg	20.444,05
10	Minyak Bekisting	Liter	45.000
11	Balok Kayu Kelas II	m^3	1.000.000
12	Plywood t = 3 mm	Kg	329.175
13	Besi Beton	Kg	12.444,05
14	Pipa Baja Ø40 cm	m’	380.000
15	Sheet Pile CCSP W-500-A-1000	m’	1.425.000
16	Kanal C	m	29,750
17	Pelat baja t = 25 mm	Kg	13.500
18	Pipa Baja Ø5 cm	Kg	50.500
19	Kawat Beton	Kg	25.444,05

Table 2.Base Unit Price Wages

No.	Jenis Keterampilan	Satuan	Harga Upah/Jam (Rp)
1	Pekerja	Jam	11.785
2	Tukang	Jam	14.285
3	Mandor	Jam	17.150

Table 3. Base Unit PriceEquipment Rental

No.	Nama Alat	Biaya Sewa/Jam
1	Buldozer	596.252,72
2	Excavator	324.655,67
3	Dump Truck	262.006,95
4	Motor Grader	488.553,16
5	Vibro Roller	297.232,89
6	Water Tanker	290.319,34
7	Pile Hammer	475.040,94
8	Crane	780.382,240
9	Mesin Las	113.609
10	Vibrator Hammer	297.232,89
11	Ponton	574.996,95
12	Toagboat	135.944,39
13	Conc. Mixer	72.622,24
14	Con. Vibrator	27.081,82

3. DESIGN METHOD

Rankine (1857) investigated the state of stress in the ground that are in equilibrium plastic is a condition that causes each point in the land mass toward the process into a state of collapse.

Method Broms (1964a) can be used to calculate the lateral deflection of the pole that is located on the ground layer homogeneous and pure form cohesive soil (clay saturated, $\varphi = 0$) or granular (sand, $c = 0$).

Prisoners of land located on the pole ultimate cohesive soil or clay ($\varphi = 0$) increases with depth, ie from 2 Cu surface soil until 8-12 Cu at a depth of approximately 3 times the diameter of the pole. Broms (1964a) proposed a simple approach to estimate the distribution of ground pressure that secures pole in the clay, the soil detainee who hold the pole in the clay soil and the prisoners are considered equal to zero in the ground to a depth of 1.5 times the diameter of the pole (1,5d) and constant at 9 cu to a greater depth than the 1,5d.

Failure mechanisms pole loose end to a long pole (pole not stiff) and short pole (pole stiff). For a long pole, pole prisoners against lateral forces will be determined by the maximum moment which can be held pole itself (My), for a short pole, pole prisoners to more lateral force is determined by the detainee soil around the pole. *f* defines the location of the maximum moment, at which point the style of latitude on the same pole with nol.Dari balance the horizontal force can be obtained:

f = Hu / (9cud)

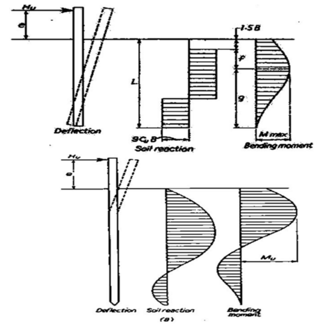

Figure 12. Mechanism collapse Pole Short and Long Pole on Pole Edge Freedom in Cohesive Soil (Broms, 1964)

By taking a moment to the point at which moment on the pole reaches its maximum, can be obtained.

By knowing the value of $\frac{My}{d^4 \gamma K_p}$ the value of $\frac{H_u}{Kp.\gamma.d^3}$ can be determined from the image and value Hu can be obtained.

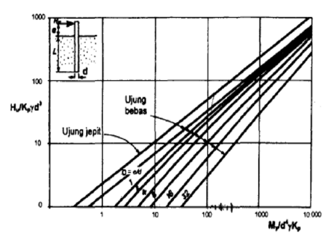

Figure 13. Prisoners ultimate Lateral Pole toin Granular Soil PoleLong

Pole ultimate capacity in cohesive soils is the number of prisoners and detainees gegsek opposite side edges. Large pole frictional resistance depends on the material and shape of the pole. Generally, when a homogeneous soil, the wall frictional resistance in the form of adhesion between the pole and the ground will have a big impact on the capacity ultimitnya.

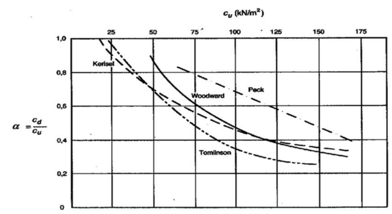

Figure 14. Adhesion Factor for Piles in Clay (McClelland, 1974)

In the picture, it appears that clay with cu <25 kN / m^{2}, α can be taken equal to 1. To determine the frictional resistance dipancang pole in the clay, used the way by using dimensionless coefficients λ suggested by Vijayvergiya and Focht (1972).

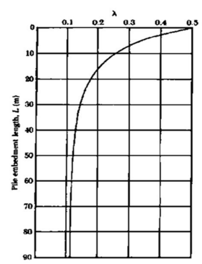

Figure 15. Relationship between the coefficient Swipe Wall (l) with Depth Penetration Tiang (Vijayvergiya and Focht, 1972)

To calculate the carrying capacity of piles based on the test data sondir can be done using methods Meyerhoff.

Wall plaster anchored suited to withstand the cliff dug deep, but they also depend on the soil conditions. The plaster walls resist lateral loads to the ground detainees rely on the plaster-rooted into the ground with helped by armature mounted on top. Depth plaster penetrates the soil depends on the magnitude of the ground pressure. For high plaster wall, steel sheet pile is required with high strength. Stability and voltages at the diangker plaster depends on many factors. For example the relative rigidity of materials plaster, plaster penetration depth, conveniences soil compression, shear strength, keluluhan armature and others.

If the depth of the peak armature block h, with h is less than 1/3 - 1 / 2H (H = depth basic blocks) see Figure 16a, the capacity of the armature (T) can calculated by assuming peak armature block extending to the surface of the ground.

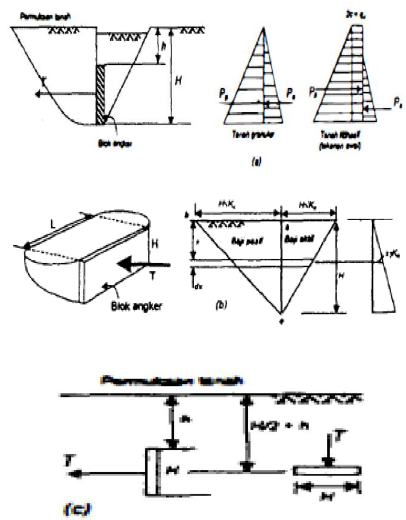

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Figure 16.Capacity Block Awful

(a) BlockAwful extends in Near Surface Soil

(b) Block Armature Short in Near Surface Soil

(c) Block Armature Located It In (Teng 1962)

In Figure 16b shows the armature block short of length L supported austere style T. observations in testing shows that when collapse occurs, the land that raised more than the length of the armature block.

The armature ultimate capacity to block the armature in (h> H) see Figure 16c is the same approach with the foundation bearing capacity which essentially lies at a depth of depth of block Y2 armature (Terzaghi, 1943).

Armature layout should be such that it is not located in the zone of unstable ground. Block austere works best if:

1. the active zone of plaster that will collapse did not cut the field of landslides block the armature.
2. Armature block is located below a line drawn from the lower end of the plaster

makes rp angle to the horizontal.

Armature block placement correct and incorrect as suggested by Teng (1962), shown in Figure 17.

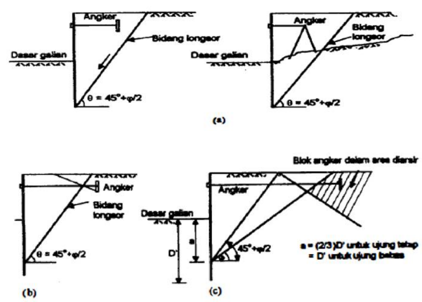

Figure 17. Placement of Armature

(a) Armature Gives Prisoners

(b) Capacity Armature Impaired

(c) Block Armature Works Full (Teng, 1962)

Stability of a slope can be analyzed manually, can also use *software*. computer Stability of slopes, slopes either natural or artificial slopes (by human labor), influenced by several factors that can be expressed simply as forces of retaining and driving forces responsible for kamantapan the slope.

The avalanche is actually a natural process to get a new slope stability conditions (new balance), wherein the retaining force greater than the motive force. To express / give more weight (level) the stability of a slope known as the so-called "Safety Factor" (safety factor). Force,if prices F for a slope> 1.0, which means retaining style> driving force, then the slope is in a state of stable / secure. But if the price of F <1.0 where the force of the retaining <style of driving, then it is in kondisis slopes are unstable and likely to occur avalanche on the slope in question. In the event that the price of F = 1.0 or magnitude of the retaining force is equal to the driving force, then the slope is in equilibrium or in other words, the slope was in critical condition.

Slope / W is aproduct softwareused to calculate the balance limit soil and slope safety factor. Analyze slope stability, use of balance, as well as having the ability to analyze soil samples of different kinds and types, landslides and the conditions in the soil pore water pressure were changed using large parts of soil samples. *Slope / w* is a sub-program of *geo-slope* that can be integrated with other sub-programs, either *vadose / w, seep / w, quake / w* and *sigma /*w.

Budget plan (RAB) is the calculation of the amount of the costs required for materials and wages, as well as other costs associated with the implementation of the building or project, building a plan in the form and avail the user along with the costs necessary arrangement -susunan implementation in the areas of administration and implementation of work in the field of engineering.

The purpose of the RAB is untuuk know the price of parts / items of work as guidance for issuing costs during implementation. Besides that building to be erected can be implemented effectively and efficiently. Mobilization and demobilization fees that include rent for land, equipment, office facilities, laboratory facilities, etc. need to be included in direct costs, and usually *lump*sum.Mobilization costs are included in the summarized and included in the preparatory work group.

4. RESULTS AND DISCUSSION

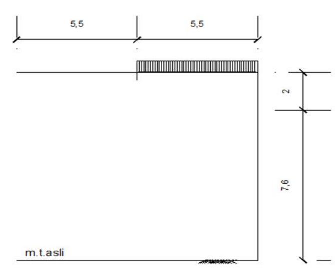

Figure 18. Sketch Piece Crossing

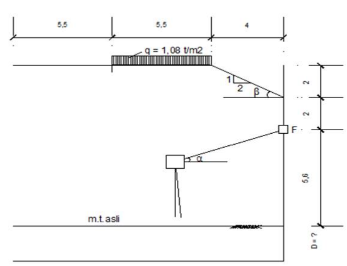

Figure 19. Sketch Planplaster on *Layout* road.

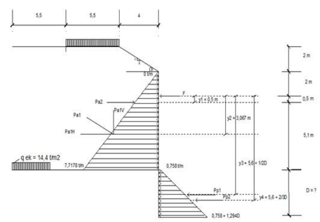

Figure 20. Sketch moment arm of the anchor

the moment of maximum without earthquakes = 34.4 tm

moment with the maximum earthquake = 34.49 tm

profile wall plaster used is CCSP type W-500-A-1000.

CCSP profile data can be seen below:

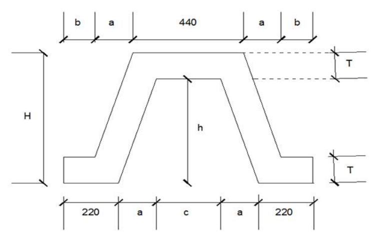

Figure 21. Sectional Profile Turap CCSP Type W-500-A-1000

a	=	140 mm	h	=	380 mm
b	=	138 mm	T	=	120 mm
c	=	276 mm	H	=	500 mm

Maximum Moment without earthquakes = 34.4 tm <*cracking moment* = 35.2 tm

moment with the maximum earthquake = 34.49 tm <*cracking moment* = 35.2 tm

From the above statement, it can be stated that the sheet pile wall CCSP type W-500-A-1000 is safe.

Style anchor = 19.82 tons.

Gording profile used is the canal without hooks 450.75.6 mm.

Profile data channels without hooks 450.75.6 mm can be seen below:

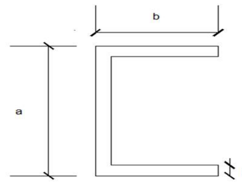

Figure 22. Sketch a cross-section Profile Channel Without Hooks 450.75.6 mm a = 450 mm, b = 75 mm and t = 6 mm

Table 4. Soil type and angle slide in (Ø)

Jenis Tanah	Sudut Geser Dalam (Ø)
Kerikil kepasiran	35° – 40°
Kerikil kerakal	35° – 40°
Pasir padat	35° – 40°
Pasir lepas	30°
Lempung kelanauan	25° – 30°
Lempung	20° – 25°

(Sumber : Buku Mekanika Tanah, Braja M. Das Jilid 1)

So we get the data of the land as follows:

Table 5. depth soil, Konus, land Descriptions, ⍰,Cu, and Ø

Kedalaman (m)	Rata-Rata Konus (kg/cm²)	Deskripsi Tanah	(ton/m²)	Cu = qc/20 (ton/m²)	Sudut geser dalam (Ø)	Keterangan
0,0 - 3,4	-	Lempung	1,79	2,55	10,09°	Data Tanah
3,4 - 4,4	36,7	Pasir kelanauan hingga lanau kepasiran	1,85	18,35	30°	Korelasi Data Sondir
4,4 - 6,2	97,9	Pasir hingga pasir kelanauan	1,9	48,95	35°-40°	Korelasi Data Sondir

Tested calculations with plaster without armature (plaster cantilever) obtained the maximum torque of 282.03 tm, which is very big moment so it is not effective for detained plaster. It is used plaster berangker.

Planned plaster armature using blocks as seen from the lateral loads that occur quite large and erection plaster depth (D) is small, so it is feared will be broken when the sheet pile resist lateral loads when not using armature block.

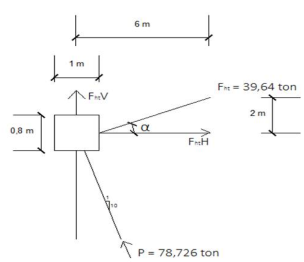

Figure 23. Sketch Planning Austere and *Tie Rod*

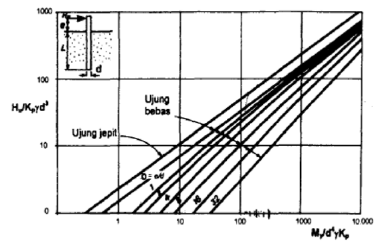

Figure 24. Prisoners ultimate Lateral Pole to Pole in Granular Soil Long

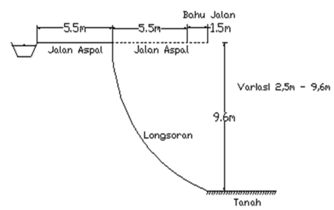

Figure 25. Sketch landslide

From the results of field measurements has the shape of an avalanche as shown above. Avalanche width of 5.5 m and a maximum height of 9.6 m avalanches. This type of avalanche is an avalanche of feet. Theoretically, a slope that has undergone sliding value SF <1.00.

Judging from the cause of the avalanche that is the absence of a drainage channel at the side of roads resulting in water overflowing and rembesannya flowing on the surface of the road. In the analysis of slope stability is not modeled the Front Air Land (MAT), this is because the road surface pavement shaped rigid or *rigid*pavement,so the water will not flow into the ground. The results of slope stability analysis using reinforcement piles can be seen as follows:

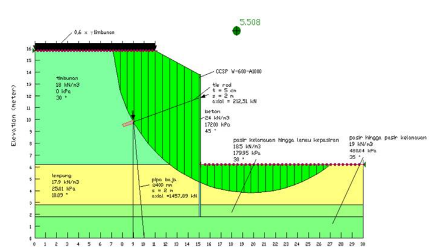

Figure 26. Results of the sliding Slope Reinforcement Piles

Based on the analysis of the calculation resultsprogram *GeoStudio* in 2007, it can be concluded that it erection plaster (12.2 m) and a depth of piles (10 m) are already qualified and can be said to be safe (SF 5.5> 1.25) because it has been sliding over the line.

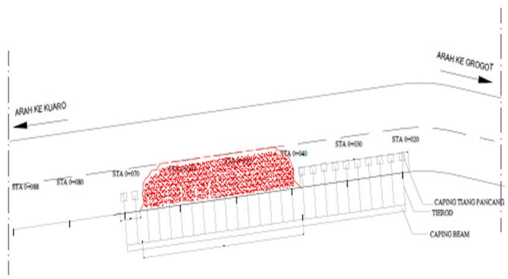

Figure 27. Results of the sliding Slope Reinforcement Piles

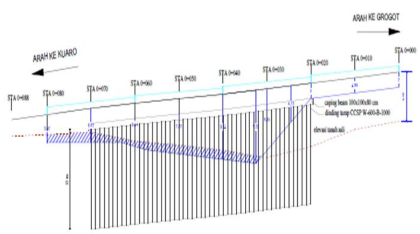

Figure 28. Results of the sliding Slope Reinforcement Piles

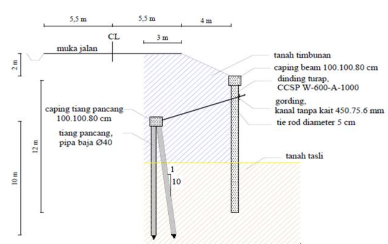

Figure 29. Results of the sliding Slope Reinforcement Piles

5. CONCLUSION

a. In the calculation depth $D_{design,}$it pancangan plaster obtained for D = 4.6 m. So the overall length of the sheet pile is 12,2 m.

b. Maximum moment obtained from the calculation of 34.49 tm, while the *cracking moment* concrete plasterCCSP type W-500-A-1000 is a maximum torque of 35.2 tm Obtained <*cracking moment* then declared safe plaster construction.

c. Austere style obtained at 19.82 tons. If thefitted *tie rod* with s = 2 m, the austere style that occurred at 39.64 tons. With the design of steel quality ST44, obtaineddiameter *tie rod* of 5 cm.

d. Carrying capacity of the pile on the armature based on the calculation results with the data obtained sondir 78.726 tonnes with SF_1 and SF= 3_2 = 5.

e. Use 2 pieces of steel piling pipe diameter of 40 cm with a depth of 10 m, to resist lateral loads amounted to 14.888 tons in each pole. By controlling the bearing carrying capacity of the lateral load, SF = 1.62. Because SF> 1.5, it can be said that the pile is safe.

f. Based on the results of slope stability analysis with the GeoStudio 2007 program, the area of the slope line is at a depth of 9 meters. It can be concluded that the 12.2 m deep pile erection and the depth of the 10 m pile has fulfilled the requirements and can be said to be safe (SF 5.5> 1.25) because it has crossed the slope line.

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