

DESIGN OF RETAINING WALLS FOR THE KUSAN RIVER CLIFF STA 4+509 to 4+628 BINAWARA VILLAGE, TANAH BUMBU REGENCY

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ABSTRACT

In Tanah Bumbu Regency, specifically the Binawara Village road plays a crucial role as the sole access road for road users. This landslide is thought to have been caused by high tides in the river alongside the road. The construction of a retaining wall in the form of a sheet pile was part of the Kusan River Bank Reinforcement Project in Binawara Village, Tanah Bumbu Regency, South Kalimantan Province. The landslide is 119 meters long, 6 meters wide, and 8 meters high. The erosion of the river water, which is increasingly wearing away at the cliff, will cause a landslide on the road.

The design of this retaining wall began with a literature study, collecting and studying previous literature related to the design. This was followed by data collection and soil investigation. This was followed by a stability analysis of the existing retaining wall. This was then modeled and analyzed using Geostudio 2024 software to obtain a safety factor. Finally, the retaining wall and overall stability were calculated.

From the results of the stability analysis of the existing retaining wall, a safety factor of $0.995 < 1.5$ was obtained, which means the slope is not safe. In the calculation of the depth D_{design} , it was obtained in the sheet pile of $D = 9$ m. So the total sheet pile length is 17 m. The maximum moment obtained from the calculation was 22.58 t.m, while the cracking moment of the concrete sheet pile type was 23.40 t.m. The maximum moment $<$ cracking moment was obtained, so the sheet pile construction was declared safe. The anchor force obtained was 56.51 tons/m. If a tie rod with $s = 1$ m was installed, the anchor force that occurred was 7.06 tons/m. With the ST-44 steel quality design, the tie rod diameter was 350.14 cm^3 . Based on the results of the overall stability, it can be concluded that it has met the requirements and can be declared safe ($SF 2.027 > 1.5$).

Keywords: *Retaining Wall, Sheet Pile, Overall stability, safety factor, anchorage.*

1. INTRODUCTION

Tanah Bumbu Regency is a regency in South Kalimantan province. It was established as a division of Kotabaru Regency, established by Law Number 2 of 2003 on April 8, 2003, concerning the Establishment of Tanah Bumbu Regency and Balangan Regency in South Kalimantan Province. The regency covers an area of 5,066.96 km² and has a population of 346,336.

The landslide that occurred on the cliffs on the side of the Kusan River, located next to Kusan Road, has reduced the smoothness and comfort of travel. Furthermore, the cliff's high condition has caused erosion due to the flow of the Kusan River, causing landslides. Large amounts of water seep into the ground and accumulate at the base of the slope, causing landslides. Therefore, repairs or landslide management are being carried out in this area to restore smoothness, safety, and comfort in traffic for people passing through this location.

Tanah Bumbu Regency's hydrological system consists of several rivers, including the Kusan River. The Kusan River is located in Kusan Hulu District, Tanah Bumbu Regency, South Kalimantan. The Kusan River flows through several villages, one of which is Binawara Village, Kusan Hulu District, Tanah Bumbu Regency. The main and only road in the village is along the Kusan River. Currently, landslides have occurred on several sections of the riverbank, potentially cutting off the road to Binawara Village and hampering residents' activities.

2. . THEORETICAL BASIS

Landslide

According to Hardiyatmo (2012), a landslide is defined as the mass movement of soil or rock in an area prone to landslides. Mass movement occurs when a large mass of soil moves along a critical landslide plane. This mass movement occurs when the material forming the slope slides down. This material can consist of soil, rock, and fill, or a combination of other materials. Landslides occur when the mass of soil moves excessively.

Slope Stability

A slope is a surface of the earth that forms a certain angle of inclination with the horizontal plane (Gazali et al., 2020). (Das, 1985) explains that a land surface that has a certain angle of inclination with the horizontal plane and is not protected is called an unretained embankment. This embankment can be formed naturally or artificially. If the ground surface is uneven, the component of the soil weight parallel to the slope of the embankment will cause the soil to move downward.

Retaining Wall

A retaining wall is a structure designed to hold loose or naturally occurring soil and prevent collapse on sloping land or slopes whose stability cannot be guaranteed by the slope itself. The retained soil exerts active pressure on the wall structure, so that the structure tends to shift or overturn. (Kurniawan & Endayanti, 2022). (Salehudin et al., 2021) explain, a retaining wall is a structure designed to prevent material from sliding according to the natural slope where its stability is influenced by topographic conditions.

3. METHOD

The research location for this final project is Sungai Binawara Village, located in Kusan Hulu District, Tanah Bumbu Regency, South Kalimantan. The data used in this final project are in the form of topographic surveys and soil investigations conducted in the field followed by laboratory testing. This slope stability analysis was carried out using Geo-Slope/W 2024 software by modeling the slope geometry based on actual conditions in the field. The type of retaining wall chosen in this final project is using a Sheet Pile (Pile) retaining wall. The sheet pile calculation analysis takes into account the depth of sheet pile penetration, maximum moment and force on the anchor.

4. RESULTS AND DISCUSSION

Existing Slope Stability Analysis

Slope stability analysis is carried out to evaluate the level of slope safety against potential landslides that may occur at the planning location.

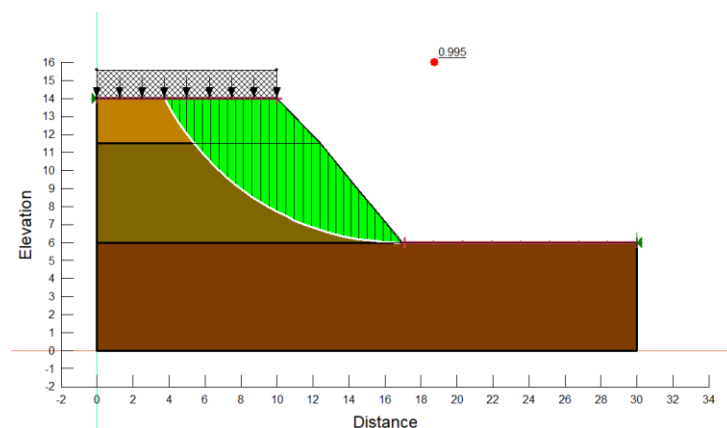


Figure 1. Existing Stability Analysis Using Geo-Slope/W 2024

Distribution of Earth Pressure

How the pressure from the soil is distributed on the sheet pile construction

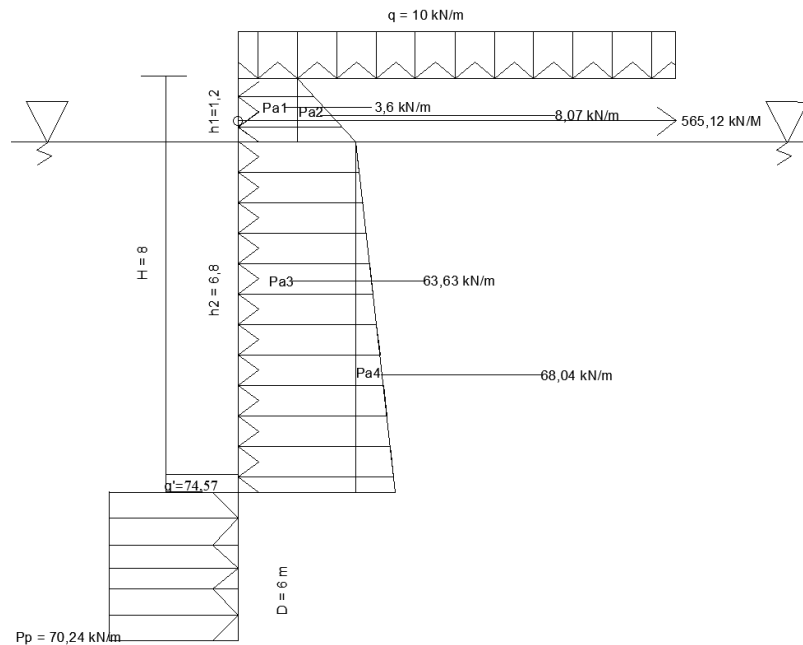


Figure 2. Earth Pressure Distribution Diagram

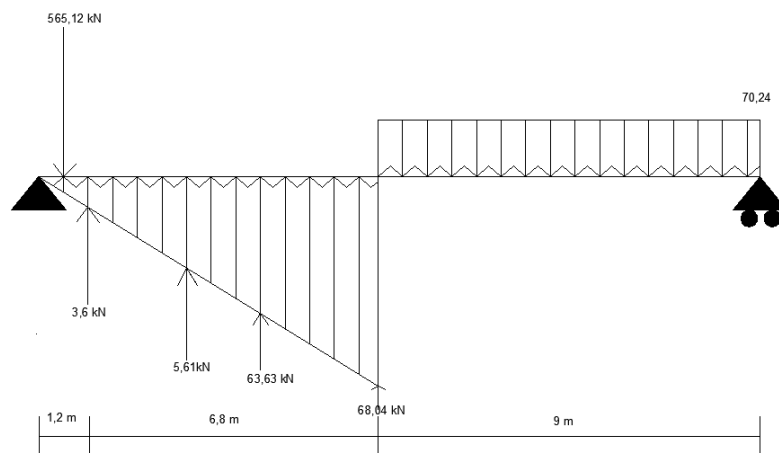


Figure 3. Load Distribution on the Sheet Pile

Maximum Moment on Sheet Pile (Using SAP2000)

calculate maximum moment using SAP2000 software analysis

Tabel 1. Moment Force Results using SAP2000 software analysis

TABLE: Element Forces - Frames												
Frame	Station	OutputCase	CaseType	P	V2	V3	T	M2	M3	FrameElem	ElemStation	
Text	m	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m	Text	m	
2	6.31429	DEAD	LinStatic	0	244.313	0	0	0	-222.8054	2-1	6.31429	
3	8.5	DEAD	LinStatic	0	-319.822	0	0	0	-168.6922	3-1	8.5	
2	5.82857	DEAD	LinStatic	0	211.494	0	0	0	-112.1157	2-1	5.82857	
2	5.34286	DEAD	LinStatic	0	178.827	0	0	0	-17.3298	2-1	5.34286	
1	1.2	DEAD	LinStatic	0	5.529	0	0	0	-3.0755	1-1	1.2	
2	0	DEAD	LinStatic	0	-170.405	0	0	0	-3.0755	2-1	0	
1	0.8	DEAD	LinStatic	0	3.417	0	0	0	-1.2953	1-1	0.8	
1	0.4	DEAD	LinStatic	0	1.574	0	0	0	-0.3059	1-1	0.4	
1	0	DEAD	LinStatic	0	-1.142E-12	0	0	0	-5.708E-13	1-1	0	
3	9	DEAD	LinStatic	0	-354.946	0	0	0	-3.389E-13	3-1	9	
2	4.85714	DEAD	LinStatic	0	146.314	0	0	0	61.6268	2-1	4.85714	
2	0.48571	DEAD	LinStatic	0	-139.422	0	0	0	72.1745	2-1	0.48571	
2	4.37143	DEAD	LinStatic	0	113.953	0	0	0	124.8282	2-1	4.37143	
2	0.97143	DEAD	LinStatic	0	-108.286	0	0	0	132.3383	2-1	0.97143	
2	3.88571	DEAD	LinStatic	0	81.746	0	0	0	172.3489	2-1	3.88571	
2	1.45714	DEAD	LinStatic	0	-76.996	0	0	0	177.3416	2-1	1.45714	
2	3.4	DEAD	LinStatic	0	49.691	0	0	0	204.263	2-1	3.4	
2	1.94286	DEAD	LinStatic	0	-45.554	0	0	0	207.1101	2-1	1.94286	
2	2.91429	DEAD	LinStatic	0	17.79	0	0	0	220.6451	2-1	2.91429	
2	2.42857	DEAD	LinStatic	0	-13.959	0	0	0	221.5693	2-1	2.42857	

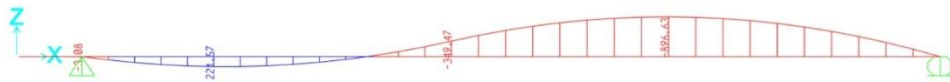


Figure 4. Moment Diagram using SAP2000 software

Sheet Pile Design

Known maximum moment = 221,56 kN.m/m

= 22,58 ton.m/m

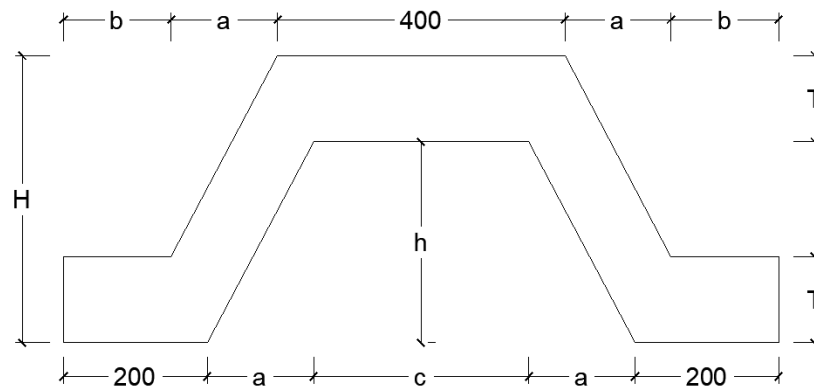
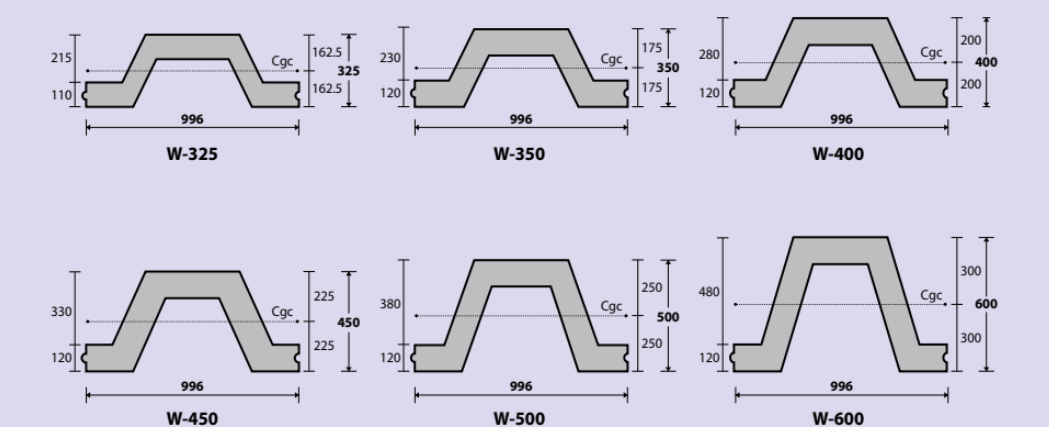


Figure 5. Cross-section of the W – 400 - B Type Sheet Pile Profile

a	=	148	h	=	280
b	=	150	T	=	120
c	=	300	H	=	400

Table 2. WIKA Sheet Pile Profile

PRODUCT SHAPE & SPECIFICATION CORRUGATED PRESTRESSED CONCRETE SHEET PILES										
										
CPC SHEET PILES SPECIFICATION										
Concrete Compressive Strength $f'_c = 62 \text{ MPa}$ (Cube 700 kg/cm^2)										
Type	Width (mm)	Cross Section (cm ²)	Section Inertia (cm ⁴)	Unit Weight (kg/m)	Class	Moment (ton.m) Crack	Moment (ton.m) Break	Allow. Service Moment (ton.m) Temporary	Allow. Service Moment (ton.m) Permanent	Length* (m)
W-325	996	1,315	134,264	329	A	11.40	22.80	10.07	6.74	8 - 15
					B	13.30	26.60	11.97	8.64	8 - 16
W-350	996	1,468	169,432	368	A	15.60	31.20	14.04	10.14	9 - 17
					B	17.00	34.00	15.44	11.54	10 - 18
W-400	996	1,598	248,691	400	A	20.10	40.20	18.10	13.08	10 - 18
					B	23.40	46.80	21.40	16.38	11 - 20
W-450	996	1,835	353,363	459	A	26.90	53.80	24.37	18.04	11 - 20
					B	30.70	61.40	28.17	21.84	12 - 21
W-500	996	1,818	462,373	455	A	35.20	70.40	32.22	24.76	12 - 22
					B	40.40	80.80	37.42	29.96	13 - 24
W-600	996	2,078	765,907	520	A	50.60	101.20	46.48	36.19	14 - 25
					B	59.60	119.20	55.48	45.19	15 - 27

Note : * Length of Concrete Corrugated Sheet Piles may exceed usual standard whenever lifted in certain position

From Table 2, the cross-section of the profile of the Corrugated Prestressed Concrete Sheet Pile Type W-400-B-23.40 based on the fill soil because the moment crack value in the table is greater than the moment crack value in the calculation, namely $M_{\text{crack}} 23.40 = \text{ton.m} > M_{\text{maks}} = 22.58 \text{ ton.m}$ so that the sheet pile is declared safe.

Stability Analysis with Sheet Pile Reinforcement

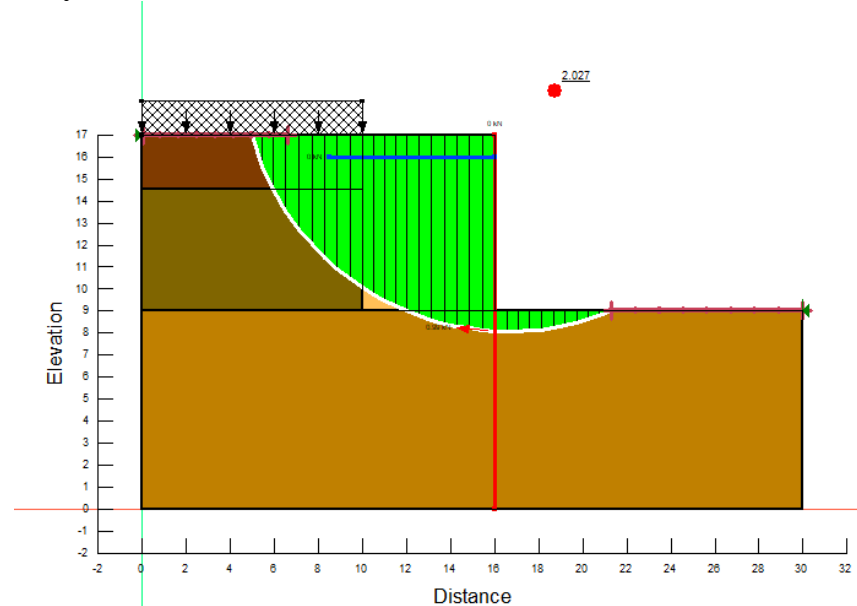


Figure 6. Results of Slope Landslide with Sheet Pile Reinforcement

Based on the analysis of the calculation results of the GeoStudio 20024 program, it can be concluded that the depth of the sheet pile driving (17 m) and the length of the anchor (7.5 m) have met the requirements and can be said to be safe ($SF\ 2.027 > 1.5$) because they have passed the landslide line.

5. CONCLUSION

Based on the results of the analysis and calculations on the retaining wall of the sheet pile type on the Kusan River cliff in Binawara Village, Tanah Bumbu Regency, South Kalimantan, the following conclusions can be drawn:

1. Based on the results of the Existing Analysis on the Kusan River Cliff, Binawara Village, Tanah Bumbu Regency, $SF = 0.995 < 1.25$, which means the slope is unstable and prone to landslides.
2. The type of construction used for landslides on the Kusan River Cliff, Binawara Village, Tanah Bumbu Regency is the Sheet Pile or Retaining Wall Type with a landslide length of 119 meters and a fill width of 6 meters and a landslide height of 6.8 meters from below the water level and 1.2 meters from above the water level.

- a The retaining wall used in the design of this Final Assignment is a Concrete Retaining Wall.
- b In calculating the depth D_{design} , it is obtained that the sheet pile is $D = 9$ m. So the total length of the sheet pile is 17 m.
- c The maximum moment obtained from the calculation is 22.58 t.m, while the cracking moment of the concrete sheet pile type is 23.40 t.m. The maximum moment is $<$ cracking moment, so the sheet pile construction is declared safe.
- d The anchor force obtained is 56.51 tons/m. If a tie rod with $s = 1$ m is installed, the anchor force that occurs is 7.06 tons/m. With the ST-44 steel quality design, the tie rod diameter is 350.14 cm.
- e Based on the overall stability results, it can be concluded that it has met the requirements and can be declared safe ($SF\ 2.027 > 1.5$).

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