Lowland Technology International; Volume 24 (Issue No. 3): 19-27
International Association of Lowland Technology (IALT): ISSN 1344-9656

Research Paper

Stability of Trash Trap Design in Various River Estuary

Hairullah [1], T. Harianto [2], A. B. Muhiddin [3], and U. Zahra [4]

ARTICLE INFORMATION

Article history:

Received: 2 December, 2022
Received in revised form: 2 February, 2023
Accepted: 18 February, 2023
Publish on: 20 February, 2023

Keywords:

Structure design
Trash Trap
SAP 2000

ABSTRACT

In Indonesia, the most serious issue is garbage. As a result, with a total waste of 1.92 million tons, it has been named the number two contributor of plastic waste to the sea. Garbage disposal in the river can be harmful to downstream residents, especially fishermen. Because of the accumulation of garbage in the riverbed, the river becomes very shallow, causing the water to overflow when it rains, which can cause flooding. The goal of this final project is to design superstructure and substructure dimensions and reinforcement. To reduce waste entering the sea, trash traps are built in estuaries by filtering surface waste. The Floating Trash Trap model, as well as its dimensions and sizes, is the scheme and design of the planned trash trap. The focus of the superstructure is on the control of steel profiles and bolt anchors, while the focus of the substructure is on the foundation. SAP 2000 software was used for structural design analysis. The superstructure design results were safe for all existing loading combinations.

1. Background

Rapid population growth has a positive impact on the economy of a region through the development of economic centers to meet all the needs of society. But on the other hand, the negative impact of the high population growth is the emergence of environmental pollution problems, especially waste that comes from the community. Garbage is the biggest problem in Indonesia. Throwing garbage into the river is a behavior that is often carried out by residents who live around the river, the amount of garbage that enters the river is detrimental to residents downstream, especially fishermen. The type of waste that enters the river is plastic waste which cannot be decomposed making the condition of the river very shallow due to the accumulation of waste in the riverbed, causing the water to overflow when it rains and in the worst case it can cause flooding. To overcome this, handling must be carried out which can reduce waste pollution. One way to overcome this is to design a trash trap or trash trap.

Law Number 18 of 2008 concerning waste management, states that waste is a national problem management needs to be carried out in a comprehensive and integrated manner from upstream to downstream so that it provides economic benefits, is healthy for the community, and is safe for the environment, and can change people's behavior. According to the definition by the World Health Organization (WHO), waste is something that is not used, not liked, or something that is thrown away that comes from human activities and does not happen by itself. Based on the 1990 SK SNI, waste is solid waste consisting of organic and inorganic substances which

[1] Lecturer, Department of Civil Engineering, Musamus University, INDONESIA, hairulla@unmus.ac.id
[2] Lecturer, Department of Civil Engineering, Hasanuddin University, INDONESIA, triharianto@unhas.ac.id
[3] Lecturer, Department of Civil Engineering, Hasanuddin University, INDONESIA, bakrim@unhas.ac.id
[4] Undergraduate Student, Department of Civil Engineering, Hasanuddin University, INDONESIA, upezahra79@gmail.com

are considered useless and must be managed so as not to endanger and protect development infestations.

The lack of public awareness not to litter in ditches, rivers, seas, and even open land, which causes damage to air, soil, and water ecosystems, makes waste management in Indonesia difficult and complex. Environmental pollution is inseparable from cities or remote areas with high population growth. According to the table above, it explains that Indonesia is the second largest contributor of plastic waste in the oceans with a total of 1.29 million metric tons of waste found floating in the sea per year. China leads as the number 1 polluter of plastic waste in the oceans with a total of 3.53 million metric tons annually. Plastic waste that is not managed properly will hurt the environment. (Jambeck, 2015).

According to the Law of the Republic of Indonesia Number: 18 of 2008, what is meant by waste management is a systematic, comprehensive, and continuous activity that includes the reduction and handling of waste. Waste management is all activities carried out to handle waste from the time it is generated to its final disposal. Broadly speaking, waste management activities include controlling waste piles, waste collection, transfer and transport, processing, and final disposal.

The waste management mechanism in Law No.18 of 2008 concerning Waste Management includes the following activities:

Waste reduction, namely activities to overcome the generation of waste from waste producers (households, markets, and others), reuse waste from the source and/or at the processing site, and recycle waste at the source and/or at the processing site. Waste reduction will be regulated in a separate Ministerial Regulation.

Waste handling, namely a series of waste handling activities that include sorting (grouping and segregating waste according to type and nature), collection (moving waste from the waste source to TPS or integrated waste processing site), transportation (activities of moving waste from sources, TPS or integrated waste processing sites, processing of final products (changing the shape, composition, characteristics and amount of waste for further processing, utilization or return to nature and active processing of waste processing activities or residues from previous processing so that they can be returned to the environmental media.

Waste management is a systematic and comprehensive activity that includes container, collection, transportation, and final management. Waste management does not only involve technical aspects, but also non-technical aspects, namely institutions, regulatory aspects, community participation aspects, and financing aspects which are regulated by the Ministry of Public Works and People's Settlements by SNI 3242:2008 which discusses waste management in settlements. Based on whether or not waste management is not only based on technical aspects, it must also pay attention to non-technical aspects.

The following is one of the ways offered for managing waste on the surface of river streams by designing a Trash Trap to reduce waste that can enter the sea. (Hetherington, 2005)

2. Research methodology

2.1 Research locations

Trash Trap research was conducted in South Sulawesi, which is located in Maros Regency, precisely the Maros River. This activity begins with surveying an investigation to obtain primary data regarding a description of the geotechnical conditions which will later be used in designing superstructures and structures in the Trash Trap. As shown in the image below

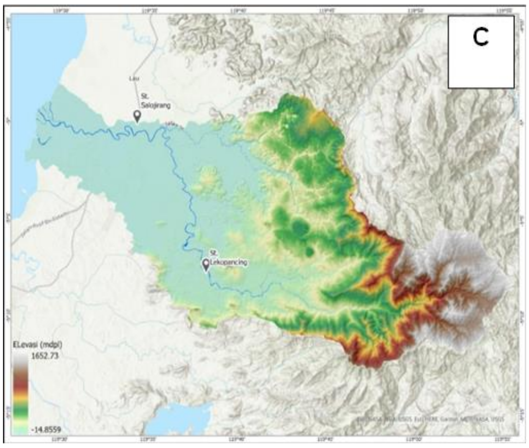

Fig. 1. Research location

2.2 Method of collecting data

The data collection methods used include:

- Literature studies or literature studies, namely studies obtained by studying or analyzing existing materials.
- Observation method by taking data related to technical data obtained directly from the research location

2.3 Building design

The planned Trash Trap design with the main concept being a floating and collapsible system. The scheme and design of the Floating Trash Trap along with its dimensions and sizes are presented in the image below. The dimensions of the Trash Trap are adjusted to the size of the material that is generally available on the market. The number of buoys (drums) installed is 8 each with a span length of 12 m. The floating material used is HDPE material with specifications resistant to exposure to sunlight so is expected that this material can be used for a long time. Span length 12 m. Furthermore, the Floating Trash Trap is tied to each of its 4 segments and connected to the anchors which are placed on the banks of the river for both the upstream and downstream sides.

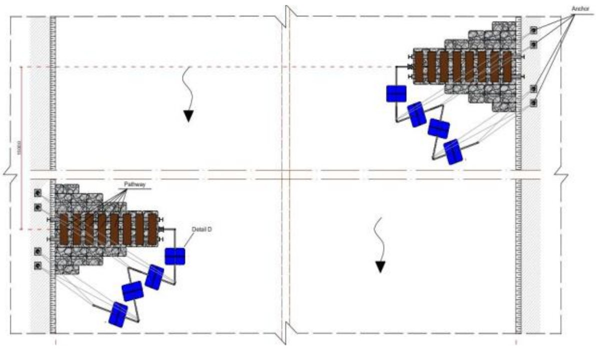

Fig. 2. Top view of the folded trash trap

2.4 Structural data and materials used

The structural data used in the Trash Trap superstructure design are as follows:

Material

(f_y) = 240 MPa

(f_{up}) = 370 MPa

(Fc') = 20.75 MPa

The bolt anchor used is Type A-325

Steel Profile WF/200/100/5.5/8

Steel cable with (fy) = 1725 Mpa

HDPE (High Density Polyethylene Drum with ∅ 600 mm

Trash net weighing 40 kg

The type of pole used is the steel pipe with ∅ 0.4 m, with f_y= 240 m

The working loads are dead and live loads where the dead load in question is the dead load due to self-load (Dead Load/DL) which is calculated automatically by the SAP 2000 program. The live load used on the trash trap is 1.9 kN/m^2. Additional dead load (Superimposed Dead Load/SIDL) is defined as a dead load consisting of:

Table 1. Additional dead load

Component	Loads (/m^2)
Force of floating drums	0.61
Net distributed load	0.13

2.5 Modeling using the SAP 2000 program

Structural geometry modeling is done in SAP 2000 software about to existing data. Modeling steps with SAP 2000 begin with modeling geometry, defining material properties, and defining supports, defining loading. Load combinations used for fixed loads and temporary loads for the superstructure:

- C1 = 1.4 D
- C2 = 1.2 D + 1.6 L

Combination of loading for fixed loads and temporary loads for the substructure:

- S1 = 1.0 D
- C2 = 1.0 D + 1.0 L

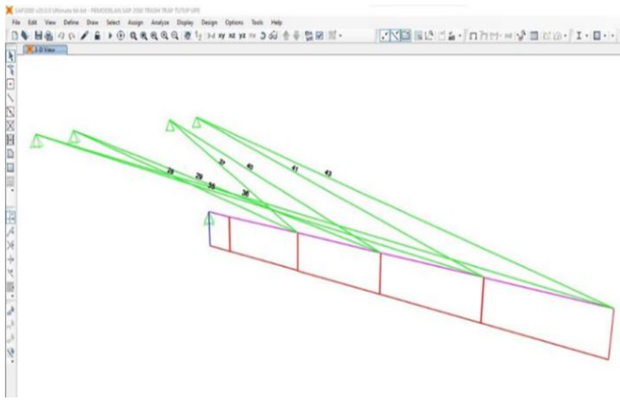

Fig. 3. The perspective of the trash trap

2.6 Geotechnical investigation

In geotechnical investigation work using the Cone Penetration Test (CPT). The purpose of this test is to obtain information data on the underground strata which will later be used in making a physical design of the Trash Trap design. Data collection was carried out at 2 locations. Readings are taken for each pipe pressure as deep as 20 cm. CPT is stopped when the readings show 250 kg/cm2 successively. The results obtained are qc values.

Fig. 4. CPT testing locations

The purpose of this research is to obtain data and information on subsurface strata that can be used as parameters to create a physical design that can be implemented and produce an adequate quality of implementation at an efficient cost. As for this work, the type of technical investigation carried out is CPT.

CPT is carried out using a tool with a capacity of 2.5 tons and is equipped with an Adhesion Jacket Cone.

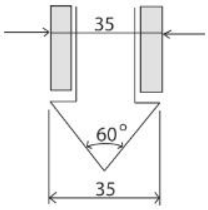

Fig. 5. Early Dutch mechanical cone (P.K. Robertson, 2015)

CPT was first carried out using a gas pipe with a diameter of 35 mm with a 15 mm steel push rod with experiments on the use of CPT equipment with a conical tip with an angle of 60°. This cone penetration is available in various sizes with a 10 cm2 and 15 cm2 probe. The detailed specifications used in this study are as follows:

- Area of the cone = 10 cm2
- Peak angle of cone = 60^0
- Area of the mantle (blanket) cone = 150 cm^2
- Area of the pressure piston = 10 cm^2

Table 2. CPT result data

CPT Result Data				
	Z_1 (m)	S-01 (kN/m^2)	Z2 (m)	S-02 (kN/m^2)
1.	0.00	0	1.00	5
2.	1.00	5	2.00	5
3.	2.00	5	3.00	5
4.	3.00	5	4.00	5
5.	4.00	5	5.00	5
6.	5.00	12	6.00	8
7.	6.00	12	7.00	8
8.	7.00	5	8.00	5
9	8.00	10	9.00	5
10	9.00	10	10.00	20
11	10.00	15	11.00	200
12	11.00	20	12.00	250
13	12.00	100	13.00	
14	13.00	250	14.00	

Data collection was carried out at 2 locations. Readings are taken for each pipe pressure as deep as 20 cm. CPT is stopped when the readings show 250 kg/cm^2 successively. The results obtained are qc values. The results obtained are value (qc) or cone penetration resistance and the amount of adhesive resistance (JHP).

The graph created is the cone penetration resistance (qc) at each depth and the cumulative amount of adhesive resistance (JHP).

2.7 Laboratory Scale Trash Trap Testing

Trash Trap Laboratory scale testing was carried out at the Integrated Engineering Laboratory, Faculty of Engineering, Hasanuddin University. The main equipment used is a wave basin, wave probe, and camera. The wave basin dimensions used are 10.0 m wide, 1.2 m high and 15 m long with a maximum water depth of 0.80. The trash Trap Design Stability Test due to current waves was carried out with three variations of wave height and one variation of water depth which can be seen in the following table. Current and wave testing is carried out by following the pattern in table 3 which has been planned.

Table 2. Wave Parameter Simulation

No	Variable	Symbol	number of variations
1	wave height	H	3
2	wave period	T	1
3	water depth	d	1

The trash trap stability test due to waves was carried out with three variations of wave height, and one wave period variation and one water depth variation. During the test, observations were made on the trash trap to determine the response that occurred due to currents and waves from upstream and downstream (estuary/tide).

3. Results and discussion

3.1 Typical trash trap design

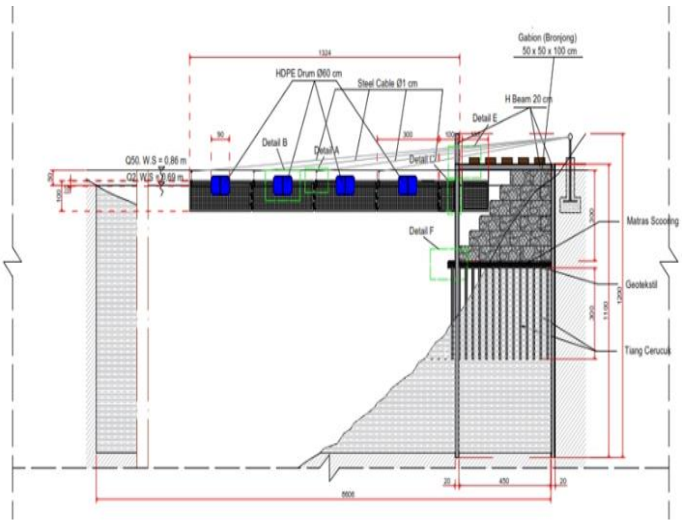

Fig. 6. trash trap design

3.2 Trash trap upper structure design

3.2.1 Steel profile control

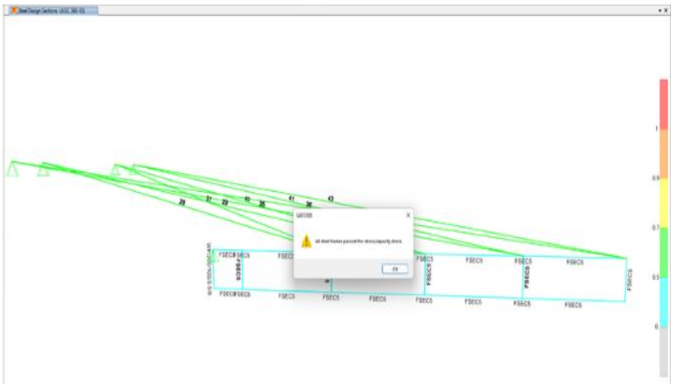

Fig. 7. Steel profile control

3.2.2 Cable tensile resistance

SAP 2000 calculation for the internal force acting on the cable shows that the maximum cable tension is T=78,116 kN. The cable tensile resistance is based on the effective cross-sectional area,

$f.Tn = 0.75\ x\ An\ x\ Fu^p$

$= 91.856\ kN$

From the calculation of the value

$T(77.323\ kN\ ) < f.Tn(91.856\ kN)$

3.2.3 Anchor load

The SAP 2000 calculation output for the anchor reaction is as follows:

Table 3. Anchor laying reaction using SAP 2000

Joint	Output	F1 kN	F2 kN	F3 kN
1	COMB1	45.494	0.00001372	0.67
1	COMB2	38.995	4.692	0.575
18	COMB1	-7.005	-1.491	1.59
18	COMB2	-86.039	-18.998	19.288
21	COMB1	-11.627	-2.557	1.695
21	COMB2	-59.544	-13.451	8.351
22	COMB1	-7.005	1.491	1.59
22	COMB2	74.031	-16.441	-16.563
28	COMB1	-11.627	2.557	1.695
28	COMB2	39.612	-9.067	-5.445
MIN		74.031	4.692	19.288
MAX		-86.039	-18.998	-16.563

It is known from the results of the analysis of the SAP 2000 structure that the vertical load received by the anchor R_y is a maximum of 17.48 kN, so the horizontal load received by the anchor is,

$R_H = (R_x + R_y)^{0.5}$

$= (76.652^2 + 17.154^2)^{0.5} = 78.548\ kN$

3.2.4 Shear force on anchor bolts

Shear force on bolt anchor, $V_{u1} = R_H = 78548\ N$ to find out the nominal shear resistance obtained by,

$V_n\ = r_1 \times m \times A_b \times f_u$

$= 0.4 \times 1 \times 380 \times 825$

$= 125444\ N$

$\phi f\ = 0{,}75 \times 125444$

$= 94083\ N$

From the results of the calculation of the value of $V_{u1}(78548\ N\ ) < \phi V_n(94083\ N)$

3.2.5 Bearing force on bolts anchor

Bearing force on bolt anchor, $Ru1 = Vu1$ = 88111 N

∅ bolt = 22 mm

t =10 mm

Plate breaking tensile stress =370 Mpa

The style of the bolt anchor that is obtained

$R_n\ = 2.4 \times d \times t \times fu$

$= 2.4 \times 22 \times 10 \times 370$

$= 195360\ N$

$\phi R_n = 0.75 \times 195360$

$= 146520\ N$

so that is obtained $R_{u1}(78548\ N) < \phi R_n(146520\ N)$

3.2.6 Bolt anchor length control

The anchor length (La) is used throughout 500 mm

Fy = 400 Mpa

∅ bolt anchor = 22 mm

fc' = 20.75 Mpa

for the minimum length of planting anchor required L min,

$L_{min} = \frac{4Fy}{(4\sqrt{Fc'})d}$

$= \frac{400}{(4\times\sqrt{20{,}75})\times 22}$

$= 483\ mm$

The conditions that must be met $L_{min}(483\ mm) < L_a(500)\ mm$

3.3 Analysis of soil carrying capacity using CPT results

3.3.1 Bearing capacity of cerucuk foundation

Based on the results of direct observation data in the field and considering CPT results as follows:

Table 4. CPT results

CPT Point	(qc),(kgf/ cm2)	(JHP)(kgf/c m2)	Depth of CPT data used
1	12	294	6 m
2	8	423	6 m
average	10	359	6 m

Then the support for the foundation of one pile of *cerucuk* can be calculated using the bearing capacity equation, with the planning data as follows:

foundation type	:	*Cerucuk* foundation	
Width	:	0.1	m
Length	:	0.1	m
Depth	:	3	m
JHP	:	358.50 kg/cm^2 (CPT Soil Test Results)	
U	:	31.42	cm
Ab	:	79	cm2
Qc	:	10.00 kg/cm^2 (CPT Soil Test Results)	
Fk	:	3.50	

then the carrying capacity for one *cerucuk* pole is equal to

$Qa1 = \frac{JHP \times U}{FK}$ = 3217.89 Kg or equal to 3.22 ton

$Qa2 = \frac{qc \times Ab}{FK}$ = 224.40 Kg or equal to 0.22 ton

Qa = Qa1 + Qa2 = 3.44 ton

3.3.2 Calculating the weight of scoring and gabion mats

Scoring mat dimensions

Length	=	1	m
Width	=	1	m
height	=	0.1	m
Stone specific gravity	=	2.2	ton/m3
Scoring mat weight	=	0.44	ton

Gabion Dimensions

Length	=	1	m
Width	=	1	m
Height	=	3	m
Stone specific gravity	=	2.2	ton/m3
Gabion Weight	=	6.6	ton

total weight = 0.44 + 6.6 = 7.04 ton

So, for every 1 m^2 it takes as many piles as Number of piles = 7.04 = 2.05 that 3 piles

3.4 Trash trap bottom structure design

The bottom structure of the Trash Trap is calculated based on the results of a preliminary survey in the form of CPT. Calculation of the structure of the bottom/foundation using CPT data refers to the Bagemann method. Details of the calculation of the substructure/foundation are described and presented in the calculation of the stability of the foundation, both resistance to axial loads, friction, end resistance of each pile, and lateral loads.

3.4.1 Pile foundation load

SAP 2000 output for foundation laying reactions as followst:

Table 6. Output of Foundation Laying Reaction Using SAP 2000

Joint	Output	F1	F2	F3
Text	Text	KN	KN	KN
1	SERV1	52.684	0.000001747	0.632
1	SERV2	8.704	-2.137	0.189
18	SERV1	-8.298	-1.758	1.836
18	SERV2	-48.468	-10.839	11.023
21	SERV1	-13.01	-2.868	1.848
21	SERV2	-29.033	-6.506	4.077
22	SERV1	-8.298	1.758	1.836
22	SERV2	45.76	-10.267	-10.328
28	SERV1	-13.01	2.868	1.848
28	SERV2	24.361	-5.478	-3.266
MAX		52.684	2.868	11.023
MIN		-48.468	-10.839	-10.328

Based on the calculation of the bearing reaction generated by the SAP 2000 application program software, the foundation load data is as follows

Table 5. foundation load data

Column axial force due to factored loads ,	$2.87\ kN$
The x-direction lateral force due to factored loads ,	$48.47\ kN$
The lateral force in the y direction due to factored loads,	$10.84\ kN$
Lateral force due to factored load,	$55.55\ kN$

3.4.2 Axial resistance of pile

Based on the strength of the pile material, the axial resistance of the pile is calculated using the following equation:

$$A = \left(\frac{\pi}{4} \times D^2\right) - \left(\frac{\pi}{4} \times (D-2t)^2\right)$$

$$= 0.0123\ m^2$$

Pole Weight, $w_p = A \times L \times w_c$

$$= 0.0123 \times 13 \times 785$$

$$= 125.03\ kN$$

Steel Quality, $f_y = 240000\ kPa$

Nominal bearing capacity of the pile,

$$P_n = f_y \times A - 1.2 \times w_p$$

$$= 240 \times 0.0123 - 1.2 \times 125.03$$

$$= 2790\ kN$$

Pile axial resistance, $\phi \times P_n = 0.33 \times 2790$

$$= 930{,}16\ kN$$

Based on the results of the CPT (Bagemann), the nominal pile end resistance is obtained which is calculated using the formula

$P_b = \omega \times A_b \times q_c$

Where,

The cross-sectional area of the pile, $A_b = \frac{\pi}{4} \times D^2$
$= 0.1257\ m^2$

Average static cone penetration resistance from 8.D above the base to 4.D below the pile base,

$q_c = 100\ kN/cm^2$

$q_c = 10000\ kN/cm^2$

With a reduction factor of the nominal end resistance value of the pile, $\omega = 0.65$

So the pile end resistance, $P_b = w \times A_b \times qc$
$= 0.65 \times 0.1257 \times 10000$
$= 816.814\ kN$

Based on the nominal frictional resistance according to Skempton, it is calculated by

$P_s = \sum (A_s \times q_f)$

Table 7. calculation of nominal pile fiction resistance

No.	Depth		L_1	A_s	q_f	P_s
	Z_1(m)	Z_2(m)	m	m^2	kN/m^2	kN
1	0	1	1	1.2566	34	42.73
2	1	2	1	1.2566	34	42.73
3	2	3	1	1.2566	34	42.73
4	3	4	1	1.2566	34	42.73
5	4	5	1	1.2566	34	42.73
6	5	6	1	1.2566	34	42.73
7	6	7	1	1.2566	34	42.73
8	7	8	1	1.2566	34	42.73
9	8	9	1	1.2566	34	42.73
10	9	10	1	1.2566	34	42.73
11	10	11	1	1.2566	34	42.73
12	11	12	1	1.2566	34	42.73
13	12	13	1	1.2566	67	84.19
14	13	14	1	1.2566	100	125.66
				$\boldsymbol{P_s = \sum(A_s \times q_f)}$		722.57

So that the axial resistance of the pile is calculated using,

$Pn = Pb + Ps$

$= 816.814 + 722.57$

$= 1539.38\ kN$

$\phi \times Pn = 0.33 \times 1539.38$
$= 513.13$

Recapitulation of the axial resistance of the pile obtained after carrying out the above calculations is as follows:

Table 8. Axial resistance recapitulation

Pile axial resistance	$\boldsymbol{\phi \times P_n}$
Based on the strength of the material	930.16
Based on CPT results (Bagemann)	513.13

The smallest axial bearing capacity is 513,13 kN, so the axial resistance of the pile is taken $\phi \times Pn = 510\ kN$

$P_{umax}(2.87) \leq \times \phi P_n(510)$

3.5 Pile lateral resistance

Pile Lateral Resistance, based on the maximum Broms pile deflection, the lateral bearing capacity of the pile can be calculated using the equation:

$$H = y_o \times K_h \times \frac{D}{[2 \times \beta \times e \times \beta + 1)]}$$

$$= 0.065 \times 7500 \times \frac{0.4}{[2 \times 4.63 \times (3 \times 4.63 + 1)]}$$

$$= 132.36$$

Pile lateral resistance, $\phi \times H_n = 0.50 \times 132.36$
$= 66.18\ kN$

It is known that the lateral resistance of the pile (H) category can be calculated by

$\beta = [K_h \times \frac{D}{4 \times E \times I}]^{0.25} = 0.35624\ m$, So,

$b \times L = 4.63 > 2.5$, then including the long pile.

Table 9. Lateral Resistance Recapitulation

No.	Pile lateral resistance	$\boldsymbol{\phi \times H_n}$
1	Based on the maximum pile deflection	$66.88\ kN$

The smallest lateral resistance is $66{,}88\ kN$, so it is taken as $66\ kN$

$H_{umax}(55.55\ kN) < \times\ \phi \times H_n(66\ kN)$

3.6 Laboratory scale testing

Current and wave tests are carried out according to the pattern and scenario that has been planned with this laboratory-scale Trash Trap, the dimensions of which are reduced based on a scale of 1:5 from the actual dimensions in the field. A Trash trap stability test due to waves is carried out by generating waves for 5 minutes. The wave height is varied for each test and starts from small waves so that the highest waves that can be generated are obtained.

Based on the wave height and other variables, then the speed of the water particles is calculated, the results are shown in the table below

Table 10. Particle speed due to waves

No.	H (m)	U max (m/s)	U_mean (m/s)	U_max prototype (m/s)
1	0,063	0,140	0,117	0,31
2	0,091	0,201	0,169	0,45
3	0,128	0,282	0,238	0,63

The test results show three wave height simulation results. From the figure it can be seen that the number of waves (n) generated was 130 with an average wave height (H) of 0.063 m, 0.091 m and 0.128 m respectively. and 0.128 m generated gives rise to an average velocity of water particles on the surface of U mean = 0.117 m/s, 0.169 m/s and 0.238 m/s, respectively. Based on these values, the velocity of water particles on the surface at the prototype scale is 0.31 m/s, 0.45 m/s and 0.63 m/s respectively. So that the velocity of water particles U max is obtained, respectively 0.140 m/s, 0.201 m/s, 0.282 m/s.

Where the velocity of the U Max water particles in question is the velocity of the water particles that have passed through the trash trap building so that the resulting water particles are smaller than the U max Prototype. During wave generation with a duration of 5 minutes or about 11 minutes on a prototype scale used with various variations of current speed.

4. Conclusion

From the results of the analysis of the design of the trash trap, the upper structure is obtained by modeling the structure with the help of SAP 2000 software in analyzing the planning of the Trash Trap, it is obtained that the steel profile control is safe against the working load. In addition, the design of the substructure specifically for the stability of the pile foundation and piles has been designed to be safe against placing reactions using soil data from the building plan location.

From the results of laboratory scale testing, it shows that the construction of the Trash Trap can be applied on a 1: 1 scale in the field

5. References

Avisan, A. B., & Koespiadi. (2019). Comparison of Building Structure Planning with SNI 2847-2013 Method and SAP2000 V.19 Software Code ACI 318-14. *IJTI International Journal Of Transportation and Infrastructure* , 2-3.

Bank, W. (2022, september 14). *Global Waste to Grow by 70 Percent by 2050 Unless Urgent Action is Taken.* Retrieved from World Bank Report: https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report

Chandra, B. (2006). *Pengantar Kesehatan Lingkungan.* Jakarta: Jakarta EGC.

Counts, T. W. (2022, september 14). *Tons of Waste Dumped.* Retrieved from globally: https://www.theworldcounts.com/counters/shocking_environmental_facts_and_statistics/world

Daniel, V. (2009). *Easy Green Living.* Bandung: hikmah.

Hetherington, J. L. (2005). *The Marine Debris Research, Prevention and Reduction Act: Apolicy Analysis.* New york: Colombia University.

Jambeck, J. A. (2015). Platic Waste Inputs From Land INto The Ocean. *Science*, 768-771.

Kusminah, I. L. (2018). Penyuluhan 4R(Reduce, Reuse, Recycle, Replace) Dan Kegunaan Bank Sampah Sebagai Langkah Menciptakan lingkungan Bersih dan Sehat di Desa Mojowuku Kabupaten Gresik. *Jurnal Pengabdian Masyarakat*, 25-28.

Mohd Nashruddin Mohd Shah, d. (2021). Proceedings of Design and Development of Trash Trap of Stream for Mini Hydro. *Teknologi Membran 2020 RCOM dan Teknologi Lingkungan Konferensi Regional 2020* (p. 2106). Johor: Elsevier.

P.K. Robertson, K. C. (2015). *Guide to Cone Penetration Testing.* California: Gregg.

Sardjono, H. (1988). *Pondasi Tiang Pancang Jilid I.* Surabaya: Sinar Wijaya.

Schueller, W. (1989). *Struktur Bangunan Bertingkat Tinggi.* Bandung: PT. Eresco.

Sihotang, I. E. (2009). Analisis Daya Dukung Tiang Pancang Pada Proyek Pembangunan Gedung Kanwil DJP dan KPP Sumbagut I Jalan Suka Mulia Medan. Tugas Akhir Fakultas Teknik Universitas Sumatera Utara

Vesic, A. S. (1997). Design of Pile Foundations, National Coorporate Highway Research Program Synthesis of Practice No. 42, Transportation Research Board, Washington, DC.

Symbol and abbreviations

A_b	Area of the bottom end of the pile
∅	Diameter
R_n	Bearing force on the anchor bolt
V_{u1}	shear force on the anchor bolt
Fc	Concrete compressive strength
Fu	Limit tensile stress
F_y	Yield stress
H	Pile lateral resistance
Pb	Pile Axial Resistance
Pb	Pile end resistance
Ps	Pile friction resistance
t	Support plate thickness
JHP	The total friction of the attachment (total friction) is the sum of the sleeve friction of the konus CPT from the top of the pile to a certain depth (kg/cm^2).
U	cross section of the foundation
Ab	foundation area

Qc Cone end resistance at ground level
Fk safety factor
ω reduction factor of the nominal end pile resistance value of the pile
A_s Surface area of the pile wall segment (m^2)
q_f Average static cone frictional resistance (kN/m^2)