3.1 Baru Pumping Station

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3.1.6 Structural Calculation of Pumping Station

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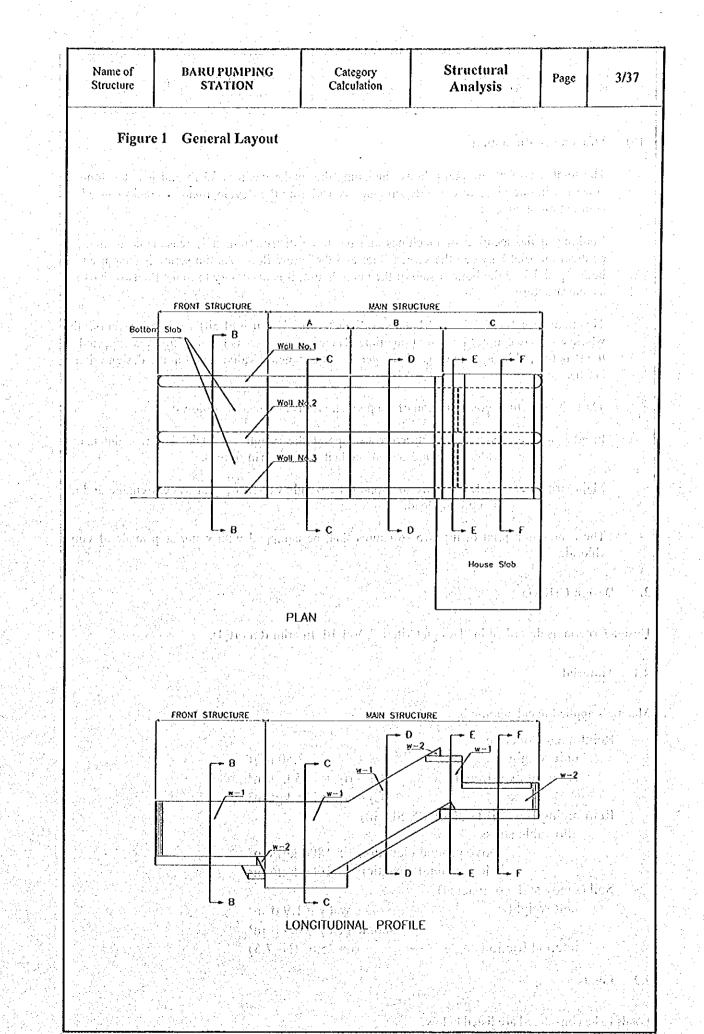
	ame of ructure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	2/37
	General	Layout			-	
he d g.l.	limension	of pump house is deter	mined by layout of	machine. The gener	al layout	is shown in
1)	Up/dov	vn stream direction				
5.	L1: spa	ce for stop log				
	L2: spa	ce for inspection road for	r stop log			
		ce for screen belt convey			i de la Contra de	
	a saa a	ce for inspection road for	the second second second second			
e je s		ce for screw	i serew and gales			
					nan Ar Ar des	
		ce for gear and engine				
•	L7: spa	ce for pump control build	ling	Los barresses.	3 	
!) (water level				
i s 20 etta		esign high water level Se				
	WL2: d	esign high water level be	hind the screen			
	WL3: d	esign low water level beh	nind the screen			
	WL4: d	esign high water in the pu	ump pond			
	WL5: de	esign low water level in t	he pump pond		お住義日 後の1000 かた長期	
)	- 10 C	structure elevation			k de set set 1955 - Sense 1957 - Sense 1957 - Sense	
•.		mping station ground lev	el			
	EL2: pu	mp pond bottom elevatio	n		l a sei Baarah	
		een bottom elevation				
)		ft bank direction				
		ce for inspection road				
		ce for screw/engine syste	m			

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Name of	BARU PUMPING	Category	Structural		$\mathcal{M}_{1} \in \mathbb{Q}^{2}_{1}$
Structure	STATION	Calculation	Analysis	Page	4/37

(5) Structure configuration

The total length of the pump house including the intake basin is 35 m and it is too long to construct in one piece of concrete structure, considering the development of cracks caused by contraction of concrete.

1 1745

Looking at the location of machines and the force distribution, it is reasonable to make a contraction joint between the screen floor and the screw floor. As the screw is supported by both top slab and the bottom slab of the pump house, it is necessary to make the two slabs act as one structure.

This main structure has a total length of 25 meter, but because of difference of elevation, the whole concrete can not be cast at one time. Therefore, no excess thermal stress is expected in the structure, although the length is longer than the standard value stated in the design criteria (15m).

Thus, the structural configuration of the pump house is designed as follows;

Front Structure: independent structure to support the weight of intake basin, maintenance bridge No.2 and screen and belt conveyor (in future).

Main Structure: single structure to support the weight of screw, gear system engine and all the building load.

The contraction joint of the two structures shall be equipped with water stop made of vinyl chloride

2. Design Criteria

Design Criteria is described in "Design Criteria", Vol. III, Interim Report(4).

2.1 Materials

Materials applied in calculation is as follows;

- Reinforced Concrete	
unit weight	2.50 m²/t
compressive strength	$C_1 = \sigma_{28} = 225 \text{ kgf/m}^2$
	$C_2 = \sigma_{28} = 225 \text{ kgf/m}^2$
 Reinforcing Bar (SII U-30 or JIS allowable stress 	SD-30)
above ground e	
below ground e	levation : 1600 kgf/cm ²
 Soil (sandy soil, compacted) 	
unit weight	wet $\gamma = 1.9$ tf/m ³
	submerged $\gamma = 0.9$ tf/m ³
internal friction angle	φ = 25.6° (N=7.5)

2.2 Loads

Loads to be considered are listed below.

Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	5/37
	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	• • • • • • • • • • • • • • • • • • • •	· · ·	
Normal cond	dition				المراجع المراجع الحاج المراجع المراجع
	eight of concrete slab in	ncluding inspectio	n path no.1 and no.2		
	weight of water	3 1			
	veight of machine and o	other structures	an a	ang ang bilang sa	
Pe: ear	th pressure		an a		inter en la compañía
Pws: h	ydro-static pressure			(al. 1)	
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			ralaan dig waard kyanan	e si n e Stelle	
				a ener	
LWo	Pe				
ΠΠ					
				n en	
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I I	v I				
Î Î			이 있는 것 같은 것을 받았다. 이 같은 것이 것 같은 것 같이 같이 같이 같이 있다.	e de la filia Sente	
		이가는 상태의 이가 가지 19년 - 영화로운 성장 가가			,
Wr	n				

Seismic condition

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Wc: weight of concrete slab including inspection path no.1 and no.2 Ww: weight of water Wm: weight of machine and other structures

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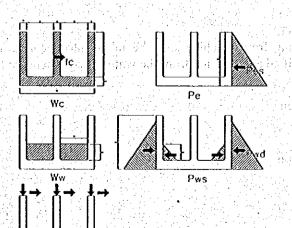
Ic, Im: seismic inertia of above all items except water

Pes: seismic earth pressure

Pws: hydro-static pressure

Wm Im

Pwd: hydro-dynamic pressure



Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	6/37	
	L	and the second			and a second second	L

2.3 Cases of Analysis

(1) Seismic status

Structural analysis is to be made in both normal condition (without earthquake) and seismic condition (with earthquake).

(2) Operation status

Since an operated screw generates dynamic force, the analysis is to be made in both cases of with pump operation and without pump operation.

(3) Stoplog status

When stop log is closed, hydrostatic pressure acts on the stoplog. Therefore, both stoplog-open and stoplog-closed status should be considered.

(4) Combination of status

When the stop log is closed, the screw pump is not operated for maintenance purpose. Therefore, combination of status is as follows;

Capatales de

Case	Seismic status	Pump operation status
and the state of the second	Normal	Not operated
2	Normal	Operated
<u> </u>	Earthquake	Operated
4	Earthquake	Not operated

Stability Analysis

3.1 Weight of Screw

3.1.1 General

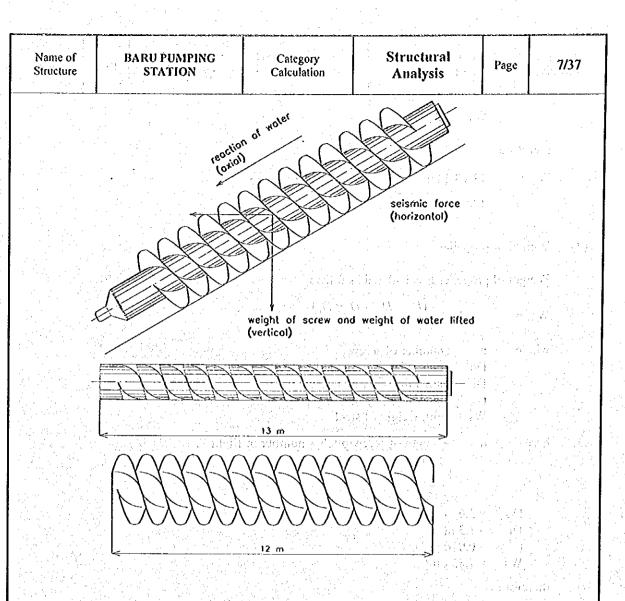
3.

In the design of civil structure, all forces acting from machine shall be taken into account. They include weight of screw itself, weight of water lifted and reaction from the water lifted. There are three calculation cases as follows;

- (case 1) normal condition without operation
- (case 2) normal condition with operation
- (case 3) seismic condition with operation
- (case 4) seismic condition without operation

3.1.2 Weight of screw

Calculation of screw weight is done for the shaft and the screw as shown below.



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<u>此后日本的目的</u>的方法的有14个对应用的表示。

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Weight of the shaft (1)

1

Weight of the shaft is calculated as follows;

$$W = 1 \times 3.14 \times \frac{(D_o + D_i)}{2} \times i \times W_s$$

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where

; length of shaft

- ; outer diameter Do
- Di 'inner diameter
 - ; thickness of plate ť
 - ws ; unit weight of steel

here for Asin Pumping station

1 = 13 m = 1.300 m Do = 1.288 m Di = 0.012 m t

Nome of
StructureAARU PUMPING
STATIONCacegory
CalculationStructural
AnalysisPage8/37Ws= 7.85 Um³thereforeW= 13×3.14×
$$(1.300 + 1.283)$$
×0.0012×7.85
= 4.981.(2)Weight of propellerWeight of propeller is calculated as follws; $W = n \times 3.14 \times (0.2 \times D_a - D_1 \times D_1)$
 $4 \times D_2$ Wherenm::unuber of screw
DoDo::uter diameter of screw
DoDo::uter diameter of screw
DiWeren::inter diameter of screw
Di::inter diameter discrew
::inter discrew
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$$V = 12 \times 3.14 \times \frac{V_2(Dp^2 - Ds^2)}{4} \times W_W$$

Name of Structure	F	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	9/37
where	w	: weight of wate	r lifted (t)			
	1	: length of shaft	(m)			
	Dp	: diameter of pro	opeller (m)			· · · · ·
	Ds	: diameter of sha	aft (m)			
	₩w	: unit weight of w	n i seran an a			
1	W	$= 12 \times 3.14 \times \frac{12}{100}$ = 5.97 t	<u>3×1.3-0.65×1.5)</u> 4	×1 → 「」」 ×1 → 「」」:「」」: 月、 → 「」:「」:「」:	an a	

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Axial component	= 5.7 × SIN30°	= 2.99 t (suppo	orted by the pr	opeller)	
				State of the	
Radial component	= 5.97 × COS30°	= 5.17 t (suppo	orted by the co	mcrete bed)	

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3.1.4 Reaction of water lifted

n Pre

The reaction of water lifter is calculated as follows;

where	Fr	: reaction of water lifted (t)
-	$\mathbf{Q} = \mathbf{Q}$: discharge (m ³ /s)
	v	: velocity of water (m/s)
	Ww	: unit mass of water (t/m ³)
here	Q	$= 3 \text{ m}^3/\text{s}$

	= Q/A	
19 A 19	= section area of flow	
	$= 1/2 \times 3.14 \times (1.3^2 - 0.65^2)$	
	$= 1.99 \text{ m}^2$	
v v	= 2.2/1.99 = 1.11 m/s	
Ww	$= 1.0 \text{ t/m}^3$	

therefore

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 $= 2.2 \times 1.11 \times 1$ Fr = 2.44 t

The direction of the force is axial.

3.1.5 Combination of force

(case-1) normal condition without operation		an an the Article An the Article Article		n to you tao ni Trofaan Robada	
	 A set of the set of				
weight of screw : axial compone		⇒ 5.11 ->			
radial compon	ént	= 8.85	≻9t		4
(case-2) normal condition with operation			alay ang sang sang sang sang sang sang sang		
weight of screw :	al component	= 5.11 t			
rad	ial component	= 8.85 t			

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	10/37
weight o	f water lifted	axial component	= 2.99 t		n di an
	4 - • · · · ·	radial component	= 5.17 t	24.	
reaction	from water lifted	axial component	= 0	=	
	the second second	radial component	= 2.44 t	1. 	2 1
combine	d force	axial component	= 5.11 + 2.99 + 0 = 8	8.1 -> 9 t	
· · ·		radial component	= 8.85 + 5.17 + 2.44	= 16.46 →	17 t
ase-3) seismi	c condition with operat	ion		i de la composition La decimiente	
weight o		axial component	= 5.11 t	1993 - 1 997 - 1997 -	
Ť		radial component	= 8.85 t	en an an an tha an thair. An tha an tha an thair	1.1
weight o	f water lifted	axial component	= 2.99 t		
		radial component	= 5.17 t		e de la composition de
seismic l	orce acting on the scre	w			l de s
	seismic force	e (horizontal)= 14.96((weight)×0.11(seismic o	coefficient)	=1.65
		axial component	= 1.65×COS30° = 1.4	3 t	an ja
n an	가 있는 것이 있다. 이 상태의 가지에 가지 않는 것이 있는 것이 있다.	radial component	$= 1.65 \times SIN30^{\circ} = 0.1$		n in Frank
seismic f	orce acting on water				
	seismic forc	e (horizontal)	= 5.97(weight)×0.11(seismic coe	fficien
			= 0.66 t		
		axial component	$= 0.66 \times COS30^{\circ} = 0$	57 t	
		radial component	$= 0.66 \times SIN30^{\circ} = 0.2$	and the second	
reaction	from water lifted	axial component	= 0		
		radial component	= 2.44 t	14년	tert of States
combine	d force	axial component	= 5.11+2.99+1.43+0.	57 = 10.1	111
		radial component	= 8.85+5.17+0.83+0.1		
		the state of the	$= 17.62 \rightarrow 18 t$		
	c condition without ope	eration			
weight o	fscrew	axial component	$= 5.11 \rightarrow 6 t$		
		radial component	$= 8.85 \rightarrow 9 t$		
seismic i	orce acting on the scree				<u>,</u> 19
en de la destruir. Natura		axial component	= 1.65×COS30° = 1.4	3 t	
		radial component	$= 1.65 \times SIN30^{\circ} = 0.8$	33 t	
combine	d force	axial component	= 5.11 + 1.43 = 6.54 -	→7t	
		radial component	= 8.85 + 0.83 = 9.68 -	→ 10 t	
The cond	lusion is				
	ormal without operatio	n axial force	=6 t		
		radial force	=9t		10.20
case(2) n	ormal with operation	axial force	=9t		
		radial force	= 17 t		
case(3) s	eismic with operation	axial force	. ≕11 t		
		radial force	= 18 t	36.10 in A.	
case(4) s	eismic without operation		=7t		
		radial force			

All cases and acting points are shown in Table-1.

In structural analysis of concrete slab, the axial forces shall be applied on both ends of the screw shaft as the full force, considering the uncertainity of force distribution. However, the radial forces shall be applied on both ends of the screw as the half of the forces as it is certainly distributed evenly.

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	Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	11/37
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			e later)	ара 2000 години 2000 години 2000 години	1	
:				Mz Mz 2.5836298 6.88396794 6.83367794	2.5836298 6.8896794 9.4733092	
				0 0 1 0 0 0 0 1 0 0 0 0		
ł				23838 23838 25858 25838 258588 25838 25858 25858 25858 25858 25858 25858 25858 25858 25858		
					440	
	- ビンゴン 時初 住 			acting point(2) 553 1.79 553 1.79	and the second second	
				actin Mx 12,4453 12,4453	17.849 17.849 35.698	가 된 가 다. 1971년 - 1941년 - 1971년 - 1941년 -
:				1 2 × 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	20.73 20.73 20.73	an a Baile Air anns an
		4 4 4 4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	እ። የሚያ ወይ የ የ የ የ የ የ የ የ የ የ የ የ የ የ የ የ የ የ	5 ¹²	***	
			-130.5 -1	and the second	1 A A A	
			,		1. Sec. 1997	
		(Y) My 37.3229 37.3229 37.3229 149.292	21.1943 -42.3886 -42.3886 -107.181 -107.181 -214.363 -23.7544	47.5083 47.5083 -120.128 -120.128 -120.128 -120.128 -130.	-70.7523 -70.7523 -141.505	
		2 C	90.09 90.040	and a second		
		acting MK MK 99.65 99.65 99.65 1286.2 1286.2 1286.2		384.2 388.9 358.9 717.8 717.8 acting Mx* acting 226.3	V V 0	1000 - 1000 1000 - 14
		1.11 A second s second second seco			10 11 A.E.	
		У g	27.00 27.00 27.00 27.00 27.00 27.00		27.00 27.00 27.00	
					-25.686 × -68.496 × -94.182 ×	
				Constraints and the second se second second sec	et al construction de la construcción de la	
		3 888 188 188 8	56 57 500 500 56 57 500 5	and the second	74 3.00 74 8.00 75 5.50	
		1330 1331 1332 1332 1332 1332 1332 1332	21.522 43.043 108.84 -108.84 -217.67 -217.67 -25.064	Q2	.77.374 .77.374 .154.75	
			11.79 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.000		0.00 0.00 0.00	
		-107.5 -107.6 -215.2 -215.2 -210.4 -201.04 -201.05 -402.08	-174.04 348.08 -325.17 -325.17 -520.35 -650.35 -202.68	405.37 -378.69 -757.39 -757.39 -123.73 -123.73	-231.17 -231.17 -462.35	
			14.45 14.45 27.00 27.00 27.00 14.45 14.45		27.00 27.00 27.00	
		영상 경험은 것 같아요. 이 것 같아요.	00 000 00		0.0 0.0 1.7 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2	
	stem	. 5.90 1.1.3.79 1.1.79 1.1.79 1.1.79 1.1.86 1.1.79			.7.83 .7.83 .15.66	
	Leve System	Fx 7.45 1.1.45 1.45 1.45 1.489 1.14.89	24.09 24.09 22.09 22.09 22.09 24.09 24.09 24.09 24.09 24.09 24.03	28.05 -14.03 -14	8.56 8.56 17.12	
	5 5 10 10			00 bilanu 61	້. ທີ່ 1	
	Forces Acting from Screw System Yo- 6.1 m	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	main structure-A no-2 9 8.5 total main structure-C no-1 9 8.5 main structure-C no-2 9 8.5 total total (earthquoke with operation condition) main structure-A no-1 11 9 main structure-A no-2 11 9	i de la compansión 👸 💆 de la compansión de	~~	
	гсс: Ас	operation no-2 no-2 no-1 no-1 no-2 no-2 a a no-2 a a no-2 a a no-2 a a no-2 a a a a a a a a a a a a a a a a a a a	no-2 no-1 no-1 no-1 no-2	no-1 no-2 no-1 oc. 0 0 0 0 0	10.2	
		(normal without opera: main structure-A no-1 main structure-C no-1 main structure-C no-2 total (normal with operation main structure-A no-1	main structure-A no-2 total main structure-C no-1 main structure-C no-2 total (earthquake with oper main structure-A no-1 main structure-A no-1	total main structure-C no-2 tota tota (earthquake without opd main structure-A no-2 total total	main structure-C no-1 main structure-C no-2 total	
	Table)	(normal w main stru total main stru main stru total main stru main stru	main stru total main stru total (earthqua main stru	total main structur main structur tota (earthquake v main structur total	និនិ	

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	12/37
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3.2 Weight of Machine and Other Structures

3.2.1 General

Fig. 2 shows the location of machines and other structures.

The machines to be considered are screw, gear box, engine and screen. For gear box, engine and screen, estimation by factories are adopted. For screen system, future installation is taken into account.

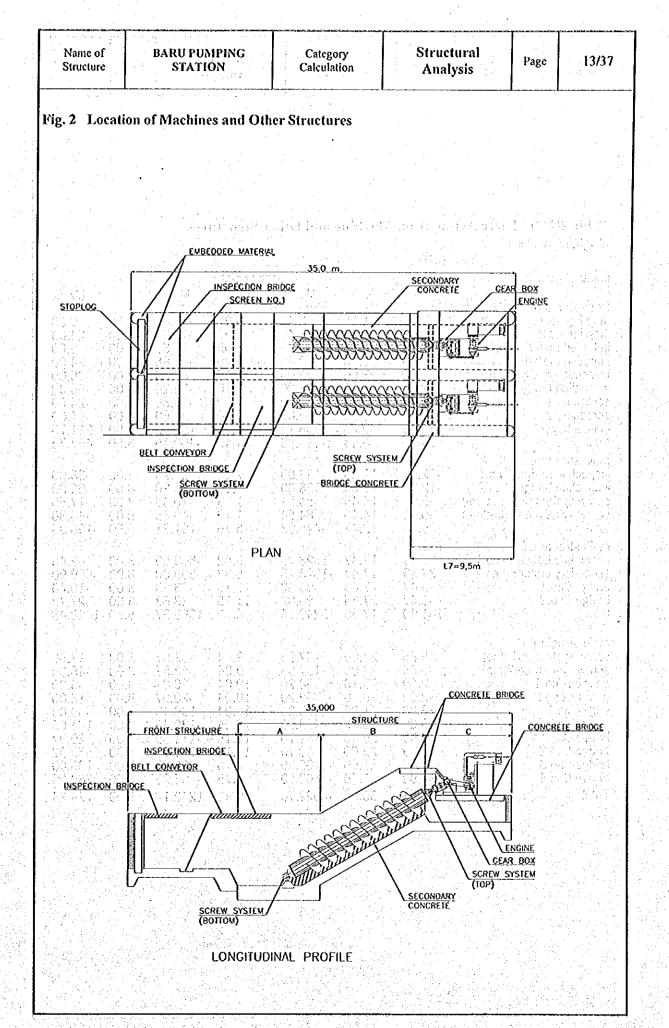
Stop log	3 t
Embedded material	
Inspection bridge	12 t
Screen	8 t
Belt conveyor	50 t
Secondary concrete	91 t
Gear box	2 t
Engine	17 t
Bridge	47 t

The seismic force acting on each machine can be calculated by multiplying seismic coefficient Kh = 0.11 to the weight of machine.

The forces acting from machine and other structures are shown in Table 2.

3.3 Weight of Pump Control Building

The weight of the Pump Control Building (architectural design) is assumed as 2.5 t/m².



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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	14/37
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 Table 2(1/2)
 Force Acting from Machine and Other Structures

 Weight of machine

v	C 10			ે પ્રસંક્રિય દ	Arres and a	÷.	- A
	-6.10			an e ^{fr} a fai		4 A.	
name	weight		acl	ling point			· . ·
		X	Mx	j y	My	Z	Mz
front structure		김 김 홍수 문	an a			N ST	1.000
stop log no.1	-3.00	1.15	-3.45	3.95	11.85	3.00	-9.00
stop log no.2	-3.00	1.15	-3.45	3.95	11.85	8.00	24.00
imbeded material no.1	-3.00	1.15	3.45	3.95	-11.85	3.00	9.00
imbeded material no.2	3.00	1.15	-3.45	3.95	-11.85	8.00	-24.00
inspection bridge A no.1	12.00	3.00	-36.00	7.10	-85.20	3.00	.36.00
inspection bridge-A no.2	-12.00	3.00	-36.00	<u> </u>	.85.20	8.00	•96.00
screen no.1 screen no.2	8.00	6.50		7.10	-56.80	3.00	-24.00
beltconbeyor	-8.00 -38.50	6.50	.52.00	2.70	-21.60	8.00	-64.00
total	-90.50	9.25	+356.13	2.70	103.95	5.50	-211.75
그렇게 물건을 가지 않는 것 같아요. 가지 않는 것 같은 것 같아요.	-20.00	6.03	-545.93	4.42	-400.15	5.50	497.75
main structure A	10.00						
inspection bridge B no.1	-12.00	11.50	-138.00	7.10	·85.20	3.00	-36.00
inspection bridge B no.2	-12.00	11.50	-138.00	7.10	.85.20	8.00	-96.00
screw system no.1(bottom) screw system no.2(bottom)	-5.85	14.45	-84.54	1.79	10.45	3.00	17.55
total	·5.85 ·35.70	14.45	-84.54 -445.08	1.79	-10.45	8.00	46.80
	-55.70	12.47	-440.06	5.36	-191.31	5.50	-196.35
main structure B	07.40	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1000 70		in i see faa		사람 가지?
secondary concrete no.1	. 87.49	17.47	-1528.75	5.82		3.00	-262.46
secondary concrete no.2	87.49	17.47	1528.75	5.82	.509.00	8.00	-699.90
bridge Cno.1 bridge Cno.2	-3.47 -3.47	27.65	.95.82	11.15	38.63	3.00	-10.40
total	181.90	17.86	-95.82 -3249.14	11.15	38.63	8.00	27.72
(O(d)	-101.90	11.00	-3249.14	6.02	1095.27	5.50	1000.48
main structure C							
screw system no1.(top)	-5.85	27.00	157.95	0.04	57.07	2.00	17 66
screw system no.2(top)	-5.85	27.00	157.95	9.04 9.04	·52.87 ·52.87	3.00	.17.55
gear box no.1	2.00	29.10	-157.95	10.04	-52.87	8.00	-46.80
gear box no.2	2.00	29.10	-58.20	10.04	-20.07	8.00	6.00 -16.00
engine no.1	-13.00	31.00	403.00	10.04	130.48	3.00	-39.00
engine no.2	-13.00	31.00	403.00	10.04	130.48	8.00	-104.00
bridge Cno.1	9.99	29.00	289.70	11.15	111.39	3.00	29.97
bridge Cno.2	-9,99	29.00	-289.70	11.15	111.39	8.00	-79.92
bridge Cno.3	35.00	31.50	-1102.50	8.75	-306.25	3.00	-105.00
bridge Cno.4	-35.00	31.50	.1102.50	8.75	.306.25	8.00	280.00
Total	131.68	30.55	4022.70	and the second	-1242.12	5.50	-724.24
						0.00	167.67

3 - 169

Name of BARU PUMPING Structural Category 15/37 Page Structure STATION Calculation Analysis Table 2(2/2) Force Acting from Machine **Incrtia of Machine** $Y_0 = .6.1$ acting point directi weight name inertia Mх x У My Z Mz оп front structure stop log no.1 -3.00 -0.33 1.15 0.38 3.95 -1.30 3.00 .0.99 ٠Z stop log no.2 -3.00 -0.331.15 .0.38 3.95 -1.30 8.00 .2.64 ٠Z imbeded material no.1 .3.000.33 1.15 0.38 3.95 -1.30 3.00 .0.99 ٠z imbeded material no.2 -3.000.33 1.15 0.38 3.95 1.30 8.00 .2.64 ٠Z inspection bridge A no.1 ·12.00 -1.32 3.00 -3.96 7.10 ·9.37 3.00 -3.96 ٠Z inspection bridge-A no.2 12.00 .1.323.00 -3.96 7.10 -9.37 8.00 10.56 Z screen no.1 8.00 -0.88 6.50 -5.72 7.10 6.25 3.00 ·2.64 .7 screen no.2 .8.00 .0.88 6.50 -5.72 2.70 ·2.38 8.00 ·7.04 ٠z belt conveyor. -38,50 4.24 9.25 .39.17 2.70 -11.43 5.50 ·23.29 ٠Z total ·90.50 .9.96 6.03 -60.05 4.42 -44.02 5.50 ·54.75 main structure A inspection bridge B no.1 12.00 -1.32 11.50 -15.18 7:10 ·9.37 3.00 -3.96 •7 inspection bridge-B no.2 -12.00 -1.32 11.50 -15.18 7.10 -9.37 8.00 .10.56٠z screw system no.1(bottom -5.850.64 14.45 -9.30 1.79 1.15 3.00 1.93 ٠z screw system no.2(bottom -5.15 -5.85 -0.64 14.45 ·9.30 1.79 -1.15 8.00 ٠z -3.93 12.47 total 35.70 48.96 5.36 -21.04 5.50 -21.60 main structure B secondary concrete no.1 -87.49 ·9.62 17.47 ·168.16 5.82 -55.99 3.00 -28.87 •7 secondary concrete no.2 -87.49 ·9.62 17.47 ·168.16 5.82 ·55.99 8.00 -76.99 •7 bridge-Cno.1 ·3.47 -0.38 27.65 +10.54 11.15 ·4.25 3.00 -1.14 bridge-Cno.2 .3.47 -0.38 27.65 +10.54 11.15 ·4.25 8.00 ·3.05 total -181.90 -20.01 17.05 -357.41 5.60 -120.48 5.50 -110.05 main structure C screw system no1.(top) .5.85 0.64 27.00 +17.37 9.04 -5.82 3.00 .1.93٠z screw system no.2(top) ·5.85 0.64 27.00 .17.37 9.04 -5.82 8.00 -5.15·-Z gear box no.1 -2 0.22 29.10 6.40 10.04 ·2.21 3.00 0.66 ٠z gear box no.2 ·2 0.22 29.10 -6.40 10.04 -2.21 8.00 1.76 ٠Z engine no.1 -1.43 31.00 -13 -44.33 10.04 ·14.35 3.00 -4.29 ٠z engine no.2 -13 1.43 31.00 -44.33 10.04 14.35 8.00 ·11.44 ٠z bridge-Cno.1 ,9.99 ·1.10 29.00 31.87 11.15 12.25 3.00 -3.30 bridge-Cno.2 12.25 8.00 .9.99 1.10 29.00 31.87 11.15 .8.79 bridge-Cno.3 .35,00 -3.85 31.50 -121,28 8.75 33.69 3.00 -11.55bridge Cno.4 35.00 -3.85 31.50 -121.28 8.75 ·33.69 8.00 .30.80 Total 131.68 14.48 30.55 442.50 9.43 .136.63 5.50 .79.67

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	16/37
4 Weight o	f Civil Structure			L <u></u> I	
	structure is calculated by	v dividing it into smal	I parts as show in the	e figure b	elow.
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n an sin Tha sin	FRONT STRUCTURE	A B	and the second	, an sa ¶≧ €a 3e	
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	Woll	<u>No.2</u>		S es e	
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		No.3			
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					1000年 中国第二人会
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	કા	AN			
		양의 사람은 것을 통한 가슴가지 같은 것을 수 있을 것을 것 같아요.		and de la Statistica	
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Table 3 For Weight of cor Y0=	rce Acting f					Analysis		Page	17/
Weight of cor	rce Acting f			· · · · · · · · · · · · · · · · · · ·	•		<u></u> I-		
-		rom Con	crete				2 (22) -		: di
-	ncrete	•		•		entra truaciante.	E. 4	A sub teach	
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slab name	name	weight			acti	ng point	÷.,		drec
		- 		Mx	·	na kang ta		100 No.	00
front structure	wal no.1-1	-122.50	x 5.00	-612.50	у 4.85	My -594.13	z 0.50	Mz -61.25	
nont structure	wall no.1-2	-122.30		-012.30	2.03	-1.54	0.50		_, • y _
	wall no.2.1	.122.50		-612.50	4.85	·594.13	5.50		•у •у
	wall no.2-2	0.76		7.29	2.03	-1.54	5.50	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	.у
	wall no.3-1	-122.50		612.50	4.85	-594.13	10.50		
	wall no.3-2	0.76	and the second	7.29	2.03	1.54	10.50	المعارية مراجع المراجع	∵.y
	bottom slab 1	-207.90		.982.33	2.00	-415.80	- <u>1</u>	-1143.45	: .y
	bottom slab 2	4.40	9.58	-42.17	1.87	-8,21	5.50		∵ -y
	bottom slab 3	-17.19	9.30	-159.84	1.45	-24.92	5.50	-94.53	.y
	bottom slab 4	1.72	9.08	-15.61	1.13	-1.95	5.50	9.45	y
	bottom slab 5	-13.75	9.50	-130.63	1.05	14.44	5.50	.75.63	·y
	total	-614.73	5.19	-3189.93	3.66	-2252.31	5.50	-3380.99	÷¥
main structure-A	wall no.1-1	-123.12	14.10	-1736.48	4.30	.529.42	0.50	61.56	y
	wal no.2-1	.123.12	14.10	-1736.48	4.30	-529.42	5.50	-677.16	y
	wall no.3-1	-123.12	14.10	.1736.48	4.30	-529.42	10.50	1292.76	y
	bottom slab-1	-293.44	14.10	. 4138.62	0.65	·190.73	5.50	-1613.90	·y
22 X 3 (19)	total	.662.80	14.10	·9348.07	2.68	-1778.98	5.50	-3645.38	
main structure B	wal no.1-1	-116.91	21.13	-2470.78	0.88	-103.33	0.50	-58.46	y
	wall no.1-2	2.88	26.00	74.86	11.78	33.93	0.50	1.44	ý
	wall no2-1	-113.18	21.13	-2391.84	0.88	-100.03	5.50	·622.46	·y
	wall no2-2	2.88	26.00	74.86	11.78	33.93	5.50	15.84	·y
	wai no3-1	-113.18	21.13	-2391.84	0.88	·100.03	10.50	-1188.34	·y
an a	wall no3-2	2.88	26.00	74.86	11.78	33.93	10.50	30.23	у
	bottom slab-1	-18.00	1 A A A A A A A A A A A A A A A A A A A	·397.82	13.15	·236.63	5.50	-98.98	·у
	total	-352.62	21.06	7427.69	1.24	·438.24	5.45	1920.73	
main structure C	wa l no.1-1	34.27	27.00	925.21	8.60	294.69	0.39	13.28	y
	walino1.2	-51.45	31.50	.1620.68	8.75	450.19	0.39	-19.94	-y
	wall no.2-1	27.97	27.00	755.27	8.60	240.56	5.50	153.85	y
-	wall no.2-2	-42.00	31.50	-1323.00	8.75	-367.50	5.50	-231.00	.у
	wall no.3-1	•27.97	27.00	.755.27	8.60	240.56	10.50	·293.71	y.
۱.	wallno.2-2	42.00	31.50	-1323.00	8.75	·367.50	10.50	•441.00	y
	bottom-1	•143.97	30.50	-4391.17	6.20	892.60	5.39	.775.63	У
 Second and the second seco	bottom-2	1	26.14	•73.90	6.83	·19.32	5.50	•15.55	·у
	bottom-3	the state of the second sec	26.40	-53.78	7.07	-14.41	5.50	-11.21	У
	bottom-4	the second second second	26,30	-111.54	6.78	-28.75	5.50	-23.33	
	total	·378.73	29.92	-11332.81	7.70	-2916.07	5.22	•1978.48	У
nouse structure	bottom	-112.38	30.51	•3428.00	8.75	-983.28	16.00	·1798.00	y
	Total Weight	·2121.25							

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Name of Structure	BARU PU STATI			gory lation		tructural Analysis		Page	18/37	•
Weight	of Water				L <u></u>		4	······································		-
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ter weight is	s calculated as	s shown in Ta	able – 4.					n in Mirine Sea	e la ca	
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		e General de la composition							an di sana Agaman	
Table 4	Weight of W	'ater					· · · ·			•
watar	level = √2.50 m			an that Na sa sa a		- 				
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	$Y_0 = -6.1$				andar Alexandra			7		
water bod	ly name – nam	ie weight			acting	g point	ini Antonio		direc tion	
front struc	ture water no	1 1 40.00	X			My	∂ z ́			
none struc	water no		5.00 9.79	-240.00 -13.67	3.00 2.03	-144.00 -2.84	3.00	-144.00		
	water no water no		5.00	240.00	3.00	-144.00	8.00	-384.00	y j	1
	total	·1.40 ·98.79	9.79 5.14	·13.67 ·507.34	2.03 2.97	2.84 293.68	8.00 5.50	-11.17		
main choic	ture-A water no	ol·l 47.91	14.10						-y	. '
	water no	51-2 2.95	14.10	-675.77 52.21	2.45	-117.39 4.75	3.00	-143.74 8.86		м. П.
	water no water no		14.10 17.67	675.77	2.45		8.00	-383.31	у	
	total	.89.92		52.21 -1247.12	1.61 2.51	4.75 225.28	8.00 5.50	23.63 494.55	-y	
main struc	ture C wall no.1			683.22	6.45	-144.48	3.00	67.20		
	wall no.2 total	2 -22.40 -44.80	30.50 30.50	1000.00	6.45 6.45	-144.48 - 288.96	8.00	·179.20 ·246.40		
						200.50	0.00	-2-10.40	.	
e Barrier de la composition de la compo La composition de la c		가 있는 것은 것이 있어. 같은 아파 이용 것이 있는	بار کې د د. لو چو د د او		a da antes Statuto		i u trá. Trác	l a sui 11 an Stàit		÷
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LONGITUDINAL PROFILE

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	19/37

3.6 Hydrostatic Pressure

Hydrostatic pressure is lateral pressure and uplift. Lateral pressure is calculated in Table - 5 while uplift is calculated in Table - 6.

3.7 Earth Pressure

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The earth pressure is calculated in Table - 7. The earth pressure coefficient is calculated in Table - 8.

Table 5 Water Pressure (earthquake condition)

Water level= 0.90 Yo= 61

100.1	L	$e_{i} = 1 + e_{i}$				a de la constante de la constan	1.5
water pressure name	height	width	P		acting point		drecti
				x Mx	y My	z Mz	01
front structure wp	3.60	11.00	83.16	1.15 95.63	4.10 340.96	5.50 457.38	3 x
front structure dwp-1	2.800	10.00	<u>,</u> 45.73	5.00 228.67	3.52 160.98	5.00 228.67	
dwp-2	2.800	10.00	45.73	5.00 228.67	3.52 160.98	10.00 457.33	3 z
total			91.47	5.00 457.33	3.52 321.96	7.5 686.00) syf
main structure A dwp-1	3.9	8.21	72.83	13.68 996.47	2.86 208.28	5.00 364.13	z -
dwp-2	3.9	8.21	72.83	13.68 996.47	2.86 208.28	10.00 728.25	ż
total			145.65	13.68 1,992.94	2.86 416.56	7.50 1,092.38	
main structure C dwp-1	0.7	9.00	2.57	31.00 79.73	6.88 17.69	5.00 12.86	z
dwp-2	0.7	9.00	2.57	31.00 79.73	6.88 17.69	10.00 25.72	z
	·		5.14	31 159.46	6.88 35.39	7.50 38.58	

water level(U/S) = -0.90m			water leve	(D/S) =	-0.47m	*		
Y ₀ = -6.10m								
waler body name name	uplift			acting	point			direct
		x	Mx	v	My	7	Mz	ion
front structure uplit	415.36	5.00	2.076.80	1.41	584.00	5.50	2,284.48	Y
main structure-A uplit	508.32	14.10	7,169.37	0.00	0.00	5.50	2,795.77	y .
main structure-B uplit	152.61	18.61	2,839.85	3.55	541.75	5.50	839.34	y
main structure-C wall no.1	-27,27	30.50	-831.78	5.80	-158.17	5.50	-149.99	v

uplift pressure= the water pressure inside of the steel sheet pile

Table 7 Force Acting from Earth (earthquake condition)

			가 좀 한 방법을		 A. 1 	an ing	
g level = 1.20						1997 - 19	
g.waterlevel = 0.35	ph	ai= 25.60	over burden = .	0.00 tm	,	a sa pa	
	1	atural soil)				it na jar	
	ų κ	, 1080 (3 0 N)					
Y ₀ = -6.1			gang na ini kala	ने संवर्धने हैं।		- i i	
	W	eight 🦾 🖓		4			direct
earth pressure name her	ght width of	soil Ka	P	a	cting point		ion
1. 人名布尔尔 · · · · · · · · · · · · · · · · · ·			×		My		Mz
front structure ep-1	6.02 10.00	106 0.47					
	5.92 10.00	1.90 0.47	-111.54 5.00	-557.70 3	42 -351.47	11.00	-1226.94 -2
그 김 아이는 그 유민이는 것			홍 한 한 말한 말				
main structure A ep-1	7.30 8.21	1.90 0.47	-115.05 14.10	-1622.73 2	43 -279 97	11.00	-1265.60 -7
2012년 17월, 갑장 동료 비수가		a da atra	法自己支持的				
main structure 8 ep-1 3.	760 770	4 66 6 47					
maarssuctoic-o ep-1 5.	750 7,79	1.90 0.47	-33.53 22.11	-/41.2/ 4.	75 -159.29	11.00	-368.88 -z
						1. 1. 1. 1. 1. 1.	
main structure-C ep-1	1.50 9.00	1.90 0.47	-8.15 31.50	-256.60 6.	30 -51.32	11.00	-89.61 -7

Name of Structure	BARU PUMPINO STATION	Category Calculation	Structural Analysis	Page	20/37	
ч.				1. 1. (1.)		
		0.474 3334 338 388 388 389 394 394 394 394 394 394 394 394 394 39				
		Кеа Кер 2.3 2.3				
	and provide the second seco		0.4318815 0.33185 0.331855 0.331855 0.3318555 0.3318555555555555555555			
		(4/180) 0-theta) 20-theta) 10-theta) 00-theta) 01-theta)		1 4 3 <i>24</i> 7 4		
		seismicity(kh) conversion(3.14/180) cos(pahi-theta0-theta) cos(theta0) cos(theta0) cos(theta-alpha-theta0) sin(phai-alpha-theta0) cos(theta-alpha) cos(theta-alpha) cos(theta-delta0)	sin(phai-delta) Sin(phai-delta)			
		25.6 con 25.6 con 25.6 con 25.6 con 25.6 cos 25.6 cos 26.6 cos 26.				
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		dition theta 0+delta	+theta +delta thetaO			
		seismic condition phai delta delta alpha alpha thetaO-theta phai-thetaO-theta phai-tdelta phai-sipha-thetaO	phai-thetao theta-thetao phai-delta phai-delta phai-delta			
		3 <i>6645</i> 666	i a f a a			
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	Coefficient (φ≕25.6°)	ፈ ፈ ተወጽለ ተዳወስ ድጽ ያና			alayan San San San San San San San San San San San San San San San	
	boold	0.0174444 0.9019304 1 0.9889409 0.5608706 0.4318815 0.4318815 0.2933399 0.2933399				
	the second se	4/180)				
	urth Pres	conversion(3.14/130) 0.0174444 Kas cos(pahi-theta) 0.9019304 Kp cos(theta) 0.9019304 1 cos(theta) 0.9339409 sin(pahi-delta) 0.9339409 sin(pahi-delta) 0.9339409 sin(pahi-theta) 0.9019304 cos(thai-theta) 0.9019304 sin(phai-delta) 0.9019304 sin(phai-delta) 0.4318815	Arren olaren daren ar der eta der Arren 1997 - Arren Arren ar der eta der			
	ion of B:					
	Table - 8. Calculation of Earth Pressure	25.6 8.533 8.533 25.6 25.6 25.6 25.6 25.6 25.6 25.6 25.6	3 2			
	Table - 8. Cal	phai delta delta alpha alpha-theta phai-theta phai-delta phai-delta phai-delta oblai-delta				
		phai delta delta alpha alpha-delta phai-delta phai-alpha phai-delta phai-delta oblai-delta				

Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	21/37
3.8 Seismic Fe			••••••••••••••••••••••••••••••••••••••	••••••••••••••••••••••••••••••••••••••	
3.8 Seismic Fe	orces				
3.8.1 Calculatio	n of Seismic Coeffici	ent in the second	a mana da da da da da	an dar	
A	Durthe Otherstein Other				
According to the	Design Criteria of the	Project, earthquake	load is calculated as fo	llows:	
$\mathbf{G} = \mathbf{E} \mathbf{x} \mathbf{M}$					
where					
G	: earthquake load	医海道 海绵的 法的变形			
Е	: horizontal earth	nquake factor			
M N	: total dead load				
	ctor is calculated using	g the following equa	tion;		
$\mathbf{E} = \mathbf{ad/g}$ $\mathbf{ad} = \mathbf{n}(\mathbf{ac};$	~ 7∖m				
au ~ n(ac .					
where					
ad	: design shock a	cceleration (cm/s ²)			
ac o		eleration (cm/s ²)			
	where				
	ac : 160 cm	n/s²	이 사람은 전 전 가지 않는 것이다. - 1913년 - 1913년 - 1913년 - 1913		
	by taking 100 y	ears for return period	a (2007)		
Ζ -	: factor dependin	g on geographical po	osition and equal 0.56 t	aking	
	northern Java Is	sland			14.4
n,m	: factor determin	ed by soil type and ta	aken as		
	0.29 and 1.32 re	espectively, for soft a	lluvium		
inally, we get E	= 0.11 for the design.				
		승규님은 승규는 것 같아요. 같아요.		e e se se se se	

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	22/37

3.9 **Total Forces**

Total forces which would act on the structure are shown in Table $9 \sim (1/4 \sim 4/4)$ and Table 10.

 Table 9 (1/4)
 Total Forces

 Z direction forces act only when earthquake is in z direction

 (case-1-1) normal condition and stop log open(pump operated)

slab name	Total Force	poi	int of actio	n	Ċ	lirectio	วท	Mom	nent footin	ig C.
		X	y y	Z	Х	Y	Z	Mx	My	Mz
front	•388.66	5.58	6.07	5.50		*		0.00	0.00	225.42
	74.97	5.00	3.42	11.00		<u>†</u>	¥	106.46	0.00	0.00
main A	-24.09	14.45	1.79	5.50	¥		· · · ·	0.00	0.00	27.46
	-596.41	14.04	5.71	5.50		*	1.00	0.00	0.00	
	96.54	14.13	2.38	10.55	· · ·		*	167.01	2.51	0.00
main C	24.09	27.00	9.04	5.50	*			0.00	0.00	68.42
	·934.56	29.47	8.88	5.50	÷.,	*		0.00	0.00	962.60
	-14.80	28.65	7.75	8.09		- (1	¥	22.94	27.38	0.00
house	-337.13	30.51	9.78	16.00				0.00	0.00	0.00

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Table 9 (2/4) Total Forces

(case-1-2) normal condition and stop log closed(pump not operation)

slab name	Total Force	po	int of actic)n	C	lirectio	on 👘	Mon	nent footir	ng C.
		X	y 's	z	X	Y	Z	Mx	My	Mz
front	71.28	1.15	4.30	5.50	*	1.1.1		0.00	0.00	249,48
	-289.87	5.72	7.12	5.50		×		0.00	0.00	208.71
	-74.97	5.00	3.42	.11.00			*	106.46	0.00	0.00
main A	-15.39	14.45	1.79	5.50	¥			0.00	0.00	17.54
	-389.17	14.13	5.97	5.50		*		0.00	0.00	10.12
	-96.54	14.13	2.38	10.55			**	167.01	2.51	0.00
main-C	-866.34	29.48	9.01	5.37		*	100	112.62	0.00	883.67
	-14.80	28.65	7.75	8.09			¥	22,94	27.38	0.00

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Table 10 (3/4) Total Forces

(case-2-1) earthquake condition and stop log open(pump operated)

slab name	Total Force	poi	nt of action	on	d	irectio	n	Мол	ent footi	ng C. 🔗
- AL		17 X (11)	y ⊺⊉	Z	X	Y	Z	Mx	My	Mz
front	77.58		3.76	5.50	¥			0.00	0.00	136.54
<u> </u>	-388.66	5.58	6.07	5.50		*		0.00	0.00	225.42
	-280.59	5.08	3.55	8.27		. ¹ 1,	• ¥	434,91	22.45	0.00
main•A	•161.96	14.25	2.28	5.50	*			0.00	0.00	263.99
a de la competition d	496.65	14.09	5.21	5.50	<u>.</u>	÷		0.00		6.9
	-383.71	13.97	2.60	7.86			*	748.23	51.42	0.00
main C	-142.12	28.64	8.59	5.44	¥			0.00	8.53	339.67
	-938.90	29.57	6.46	5.50	14.1	*		0.00	0.00	873.18
	-139.95	28.99	8.49	5.82			*	320.49	211.32	0.00
house	37.08	30.51	9.78	16.00	*			0.00	0.00	38.19
	-337.13	30.51	9.78	16.00	14	*		0.00	0.00	0.00
	37.08	30.51	9.78	16.00	· · · · ·		*	38,19	0.00	0.00

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Nam Struc	· · · ·	BARU PUMPI STATION	ING	Categ Calcul				truct Analy	ural ysis	Page	23/
		/4) Total For arthquake condi		top log cl	osed(pi	IMD	not oc	perate	ed onerat	ion)	• • • • •
	słab name	Total Force	فسيستنزيا المتلافت القالي	int of action			lirectio			nent footin	ng C.
	Sidu Haitte	Totarroice	X	y	Z	χ	Y	Z	Mx	My	Mz
fro	nt	160.71	3.15	4.04	5.50	¥	ر ارد درد ا		0.00		562.49
	1997 ¹⁹ 17	-289.87	5.72	7.12	5.50		*		0.00	0.00	208.71
	<u>al se a se s</u>	-189.12	5.13	3.56	8.66		1	*	295.03	24.59	0.00
ma	in A	.151.03	14.23	2.31	5.50	*			0.00	0.00	250.71
		395.80	14.13	5.90	5.50	10	¥		0.00	0.00	10.29
		239.67	14.15	2.43	8.06			¥	426.61	11.02	0.00
ma	in C	157.51	28.48	8.63	5.45	*			0.00	7.88	382.75
		.908.76	++		5.38		*		109.05	0.00	926.94
	111	-141.41	28.79	8.55	5.44			*	332.31	241.81	0.00

 Table 10
 Total Forces (Summary)

			·	
case no.	slab name	<u> </u>	H N	critical case
	Sido nume	11 t 546	States -	
normal condition, stop log open	F	339	75	
	Α	596	97	*
	C	935	24	*
	H	337	0	¥
normal condition, stop log closed	5 - F 1.65	dig 5 : 290	75	*
	A . A	389	assati 97	
	ad s C (1,7)	866	15	
earthquake condition, stop log open	Stell F − C.	1854 r n 389	281	*
	A A	497	384	*
	C	939	142	
	$\mathbf{H} = \mathbf{H}$	337	37	*
earthquake condition, stop log closed	SAN F	290	189	
	Α	396	240	
	C	909	158	*

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normal condition: no earthquake earthquake condition: earthquake

in stop log open condition, water weight is included in stop log closed condition, water pressure on stop log is included in earthquake condition, inertia on screw has vertical component in stop log open condition, driving force of screw is included

Name of BARU PUMPING Structure STATION	Category Calculation	Structural Analysis	Page	24/37
3.10 Pile Foundation Analysis	• • • • • • • • • • • • • • • • • • •			
3.10.1 Pile Stress Analysis				
1) N-value for design of pile foundation	on			El.0 m
Geological condition at the site is a	ssumed as shown in	Figure-11.		
N-value at pile tip (Nt): 50		El4.0m		
average N-value 3.75D above the t 3.75 D = 3.75 x 0.5 = 1.87	ip to pile tip (N2):			N=5
) x 50) / 1.875 =31.3 -	$\rightarrow 31$ $\ell_{I}=11n$	1	El.15 m
N-value for pile design (N): N = (5	$0+31)/2 = 40.5 \rightarrow 40$	€ 1 =10n	n	N==10 El25 m
		ε ₁ =1.0m	<u>↑</u> []	$\frac{E125 \text{ m}}{\text{N}=50}$
2) Estimation of internal friction angle	and the second state of the second second		<u> </u>	
$\phi = 15 + \sqrt{(15 \times N)} = 15$	+√(15 x 40) = 39.5;	동생은 이번 동안에 가지 않는 것이 있는 것이 없다.		
3) Allowable compressive bearing cap	pacity (Ra)		동안 64 도구하는	
$Ra = \frac{\{qd \times A + u(li \times fi)\}}{\{qd \times A + u(li \times fi)\}}$				
$Ra = \frac{G^{-1} - F_{SF}}{SF}$			anta Second	
qd : ultimate bearing capa A : Area of pile tip ($=\pi R$ li : stratum depth ($l_1 = 1$) u : circumferential length fi : maximum skin firicti ($f_1 = 2.5$ tf/m ² , $f_2 = 3$ tf/n SF : safety factor (normal) - ultimate bearing capacity (qd)	$k^2/4 = 0.196 \text{ m}^2$) 1.0 m, $l_2 = 10 \text{ m}$, $l_3 = 1$ h of pile (= 1.571 m) on of stratum m ² , $f_3 = 3 \text{ tf/m}^2$)	m)		
$qd = 1.3 \times c \times N + 0.3 \times R \times C \times R \times C \times N + 0.3 \times R \times C \times R \times R$	$\gamma_1 + N_{\gamma} \times Df \times Nq$			
c : cohesion (= 0)				
Nc, N _y , Nq : bearing capac Nc = 92, N _y =110, Nq = 8				
γ_1 : unit weight of soil be γ_2 : unit weight of soil ab R : diameter of pile (= 0 Df : Pile length (= 22.0 m	low pile tip (= $0.8 \text{ tf}/$ ove pile tip (= $0.8 \text{ tf}/$.5 m)	m ³) m ³)		
qd = 0.3 x 0.5 x 0.8 x 110 + 0.8 x 2;	2.0 x 85 = 1509.2 tf/n			
$Ra = \{1509.2 \times 0.196 + 1.571 \times (11.0) \times 0.196 \times 0$)0 x 2.5 + 10 x 3 + 1 x 3	$\frac{390.8}{SF}$		
 Normal condition: Ra = 130 tf Earthquake condition: Ra = 195 	i tf			

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	25/37
4) Allowabl	e pull-out capacity (Pa)	- L		Lander R	n de la composition La composition de la c
$Pa = \frac{P}{SF}$	$\frac{2u}{+\overline{w}}$		an a		
P	ate axial pull-out capacity $u = U\Sigma(Ii x fi) = 95$ i' : effective weight of p			tí)	
6- 2	F: safety factor (normal: Normal condition: F Earthquake condition: F				
	e lateral bearing capacity	(Ha)			
	e lateral bearing capacity la = (k x D /β) x δa	(Ha)			
H k D	el cara carlo de la carlo de la composición de la composición de la composición de la composición de la composi La característica de la composición de l	ection of foundation			
H k D	Ia = (k x D /β) x δa : coefficient of lateral rea): pile diameter(= 0.5 m) : charactaristic value of p $\beta = \sqrt{\frac{k \cdot D}{4 \cdot E \cdot I}}$	iction of foundation bile (cm ⁻¹)	ground (kgf/cm³)		
Η k D β	Ia = (k x D /β) x δa : coefficient of lateral rea D: pile diameter(= 0.5 m) : charactaristic value of p $\beta = \sqrt{\frac{k \cdot D}{4 \cdot E \cdot I}}$ E: coefficient of elast	iction of foundation bile (cm ⁻¹) icity of pile body (= f corss section of pile	ground (kgf/cm ³) = 400,000 kgf/cm ²) = body (= 260,604.6 m ³)	5	

$$k = k_0(B_H/30)$$

$$k_0 = \frac{1}{30} \times \alpha \times E_0.$$

$$E0 = 28N = 140, \alpha = 1 \text{ (normal)}, \alpha = 2 \text{ (earthquake)}$$

$$B_H = \sqrt{\frac{D}{\beta}}$$

$$D = 0.5 \text{ m}$$

1/1

k = 1.70 (normal condition) k = 3.40 (earthquake condition)(details see table-5)

(5)-2 Allowable lateral bearing capacity (Ha)

Ha =
$$\left(K \times \frac{D}{\beta}\right) \times \delta a$$

K: 1.70 kgf/cm³ (normal), 3.40 kgf/cm³ (earthquake)
D: pile diameter(= 50 cm)
 β : 0.0038 cm⁻¹, 1/ β = 264.5 cm
 δa : allowable displacement of pile (normal: 1.0 cm, earthquake: 1.5 cm)
Ha = 22.5 t (normal),

Ha = 67.4 t (earthquake)

Name of Structure		RU PUMPI STATION	NG		Category Calculation		Structu Analy		Page	26/3	7
6) Load and m	oment f	or a pile			· · · · · · · · · · · · · · · · · · ·			•			
				i.			·				
6)-1 Load and	moment	at footing	g cente	r							· .
Name of Structure	norm V H		ormal(Z) H I	sei M V	smic(ZX) H M	seismi V H		smic(XX)	seismic(XZ) M	
Front Structure	-290 7	458 -290	075 1	06 -389	0,225	389 .27	3 424 -389	78: 362			
Main Structure-A	-596 -24	4 65 596	5 -97 1	57 497	-24 34 -4	97 -37	5 732 -497	162 271	-497 -97	167	
Main Structure C	•	1031 -935	5 -15	23 .909			0 415 .909				
House Slab	•337 (0-337	1 0	0 337	37 9	37 3	7 9 -337	0 0	-337 0	0	
										• • •	2 A 1
R . 1									8 - 1 - 1		
Displacemen	it of Pi	es and L	oad o	on Pile	s (Baru f	Pumpi	ng Statio	n)			
Front Structure displacement of pil											
			ta H(cm)				radian)	pet adde			
normal	delta y 0.028		delta z	deita H		alpha		na este			
earthquake: z	-0.028	•	0.081		- 1-1		.18 1.84 .59 3.59	este de la	经有关 打	l e c	
earthquake:x	0.037		-0.048				. <u></u>				
load on pile											
	1.	Pv(t)		4	1	1.10					
	Pvmax				Mm(tm)			to ber			
Ismon	7.1	6.9	2,46	3.25	-0.7	2.1	beta(normal)=				
earthquake: z earthquake: x	12.9	5.5 9.0	6.72	7,55	-1.6		beta(quake)=	0.004449			
Main Structure A			1 2.34	1 2.00	0.0						
displacement of pile	e										
	L	delta H(cm)	1	1	alpha H(10-	5 radian)				
a a small	delta y					alpha z			$\mathbf{y} \in \mathcal{X}$		
normal earthquake: z	·0.05 ·0.042		0.091				27 1.37				
earthquake:x	0.042		-0.211 -0.055		0.43	-4.	11 4.13 07 3.11				
load on pile			1 0.000		<u> .c.aci</u>						2
	1	Pv(l)	1	1	1	an an an 1 Taoine an 1				alar ata F	
<u> </u>	Pvmax	Pvmin	Ph(t)		Mm(tm)						
normal	14.2						beta(normal)=				
earthquake: z earthquake: x	15.2 12.8		7.83		·1.81276	a a fa	beta(quake)=	0.00449			
Main Structure-C	1 12.01	0.1	3.33	4.30	0.90985			er verstaarte. Er och staarte			
displacement of pile	1945) • Alamanda (* 1947)					n in Nationa		n			
		delta H(cm)	1		alpha H(10-	5 radian)				
	delta y	deita x	deita z	delta H	alpha x	alpha z	alphs H				
normal earthquake: z	0.236	0.0680	0.042	0.080		0.	50 1.16	भारत वस			
earthquake:x	-0.229 -0.229		0.218	0218	0.43		55 3.58				
load on pile	1 2.022	0.2000	. 0.02.0	<u></u>	.1.92	<u> </u>	39 7.93				- -
	1	Pv(t)			 1						
	Pymax	Pvmin	Ph(t)		Mm(tm)						
normal	59.2	57.6	1.77	2.34	-0.48675	1	peta(normal)=	0.00378			
	56.9		9.56	10.65	-2.21328		beta(quake)=	0.00449			
earthquake: z	62.1	51.3	8.18	9.11	-1.89379			使的复数			
earthquake: z earthquake: x									1 A A A A A A A A A A A A A A A A A A A		
			調算機			31 EF	요즘 문서				

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Name of Structure	BARU PUMPING STATION	Category Calculation	Structural Analysis	Page	27/37
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Pile Cap Analysis

<u>F-F</u>

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normal stress in the footing concrete

 P_{Nmax} = 7.1 tf/pile (in case of normal condition)

 P_{Notat} = 12.9 tf/pile (in case of earthquake condition)

$$\delta_{cv} = \frac{P_{N \max}}{\pi D_{4}^{2}} = \frac{12900}{\frac{\pi}{4} \times 50^{2}} = 6.6 \frac{kg}{cm^{2}} < \delta_{cu} = 60.0 \times 1.5 = 90.0 \frac{kg}{cm^{2}}$$

shearing stress in the footing concrete

$$= \frac{P_{N\max}}{\pi(D+h)h} = \frac{12900}{\pi(50+70)\times70} = 0.49^{kgf}_{cm}, < \pi ca = 8.8^{kgf}_{cm}, \dots \dots O.K.$$

 $t \phi$

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horizontal punching stress in the footing concrete

$$\delta_{ch} = \frac{H}{D\ell}$$

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T₁.

= inserted pile length (cm)

M = Moment (kgf.cm)

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- II = Axial Force
- $P_{Nnicar} = 9.3 \text{ tf/pile}$ $M_{.x} = 2.85 \text{ tf.m}$ $S_{.x} = 2.54 \text{ tf}$ $P_{Nnicar} = 12.9 \text{ tf/pile}$ $M_{.z} = 7.75 \text{ tf.m}$ $S_{.z} = 6.72 \text{ tf}$

$$\delta_{ch:X} = \frac{2540}{50 \times 10} = 5.1^{kgf} / cm^2 < \delta_{ca} = 60.0 \times 1.5 = 90.0^{kgf} / cm^2 \dots O.K$$

$$\delta_{ch-Z} = \frac{67250}{50 \times 10} = 13.4^{\frac{k_{gf}}{cm}} < \delta_{ca} = 60.0 \times 1.5 = 90.0^{\frac{k_{gf}}{cm}} \dots O.K$$

horizontal punching stress in the pile

$$h = \frac{H}{h'(2\ell + D + 2h')}$$

h'

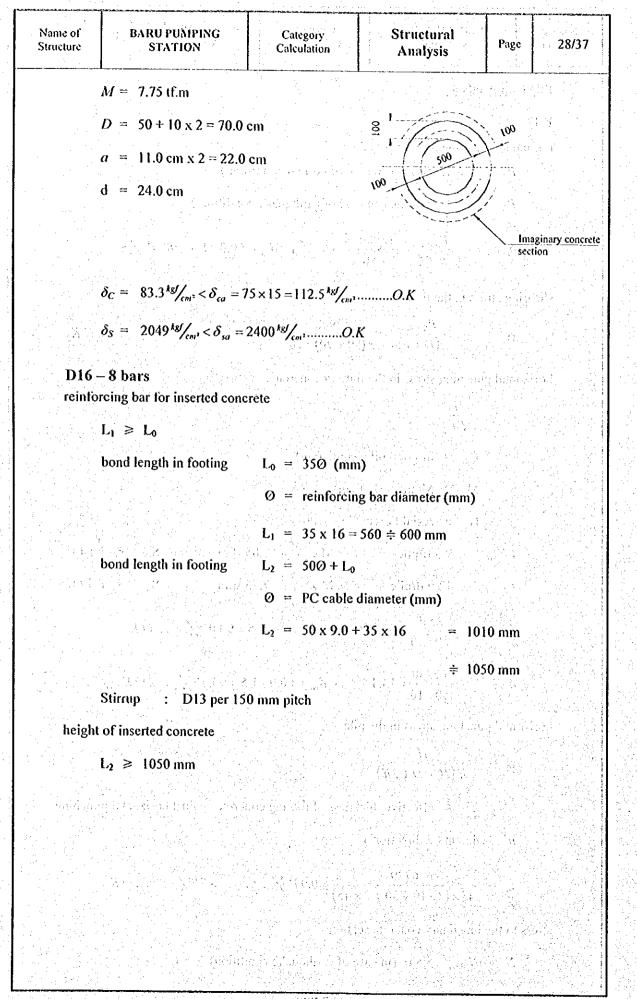
= effective thickness of footing concrete against horizontal punching

h' = 45 cm (z direction)

$$\tau_h = \frac{6720}{45 \times (2 \times 10 + 50 + 2 \times 45)} = 0.93 \frac{\text{kgf}}{\text{cm}^3} < \tau_{a3} = 8.8 \frac{\text{kgf}}{\text{cm}^3} = 0.00 \text{K}$$

stress in the imaginary concrete section

 $N = N_{min} = 5.5$ tf (in case of earthquake condition)



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AnalysisPage29/37
$$\Delta \cdot \Delta$$
(a)normal stress in the footing concrete P_{Max} = 14.2 tf/pile (in case of normal condition) P_{Max} = 14.2 tf/pile (in case of carthquake condition) δ_{cr} = $\frac{P_{Max}}{\pi^{10}/4} = \frac{15200}{\frac{4}{5} \times 50^2} = 7.7^{40}/_{cas} < \delta_{cr} = 60.0 \times 1.5 = 90.0^{10}/_{cas}$ (b)shearing stress in the footing concrete τ_r = $\frac{P_{Max}}{\pi(0+h)h} = \frac{15200}{\pi(50+70) \times 70} = 0.58^{40}/_{cas} < tca = 8.8^{10}/_{cas}$.(c)horizontal punching stress in the footing concrete δ_{ct} = $\frac{H}{D\ell}$ ξ = inserted pile length (cm)M= Moment (kgf.cm)H= Axial Force P_{Max} = 12.8 tf/pile M_{x} = 8.72 tf.m S_{x} = 7830 δ_{ck-x} = $\frac{7830}{50 \times 10} = 15.7^{10}/_{cas} < \delta_{ca} = 60.0 \times 1.5 = 90.0^{10}/_{cas}$.(d)horizontal punching stress in the pile h'_{a} = $\frac{7830}{50 \times 10} = 15.7^{10}/_{cas} < \delta_{ca} = 60.0 \times 1.5 = 90.0^{10}/_{cas}$ $O.K$ δ_{ck-x} = $\frac{7830}{50 \times 10} = 15.7^{10}/_{cas} < \delta_{ca} = 60.0 \times 1.5 = 90.0^{10}/_{cas}$ $O.K$ (d)horizontal punching stress in the pile h'_{b} = $\frac{H}{h/(2t + D + 2h)}$ h' = effective thickness of footing concrete against horizontal punching $h' = 45$ cm (z direction) h_{b} = effective thickness of footing concrete against horizontal punching $h' = 45$ cm (z direction) h_{b} <

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Name of StructureDA RU PUNIPING
STATIONCategory
CalculationStructural
AnalysisPage30/37(c)stress in the imaginary concrete section
$$M = N_{min} = 5.6 \ ff$$
 (in case of earthquake condition) $M = 8.72 \ ff.m$ $D = 50 + 10 \ x 2 = 70.0 \ cm$ $a = 11.0 \ cm \ x 2 = 22.0 \ cm$ $d = 14.0 \ cm$ $\delta_{C} = 94.4^{16} / \omega_{cd}^{1/2} < \delta_{cd} = 75 \times 15 = 112.5^{16} / \omega_{cd}^{1/2}, \dots, O.K$ $\delta_{C} = 94.4^{16} / \omega_{cd}^{1/2} < \delta_{cd} = 75 \times 15 = 112.5^{16} / \omega_{cd}^{1/2}, \dots, O.K$ $\delta_{C} = 2350^{16} / \omega_{cd}^{1/2} < \delta_{cd} = 2400^{16} / \omega_{cd}^{1/2}, \dots, O.K$ $b_{C} = 2350^{16} / \omega_{cd}^{1/2} < \delta_{cd} = 2400^{16} / \omega_{cd}^{1/2}, \dots, O.K$ $D16 - 8$ bars(f)(g)reinforcing bar for inserted concrete $L_1 \ge L_0$ bond length in footing $L_2 = 502 + L_0$ $\Theta = PC \ cable \ diameter (mm)$ $L_2 = 50 \times 9.0 + 35 \times 16$ $L_2 = 1030 \ mm$ StirupStirupStirupStirup $M = 1350 \ mm$ $L_2 = 1050 \ mm$

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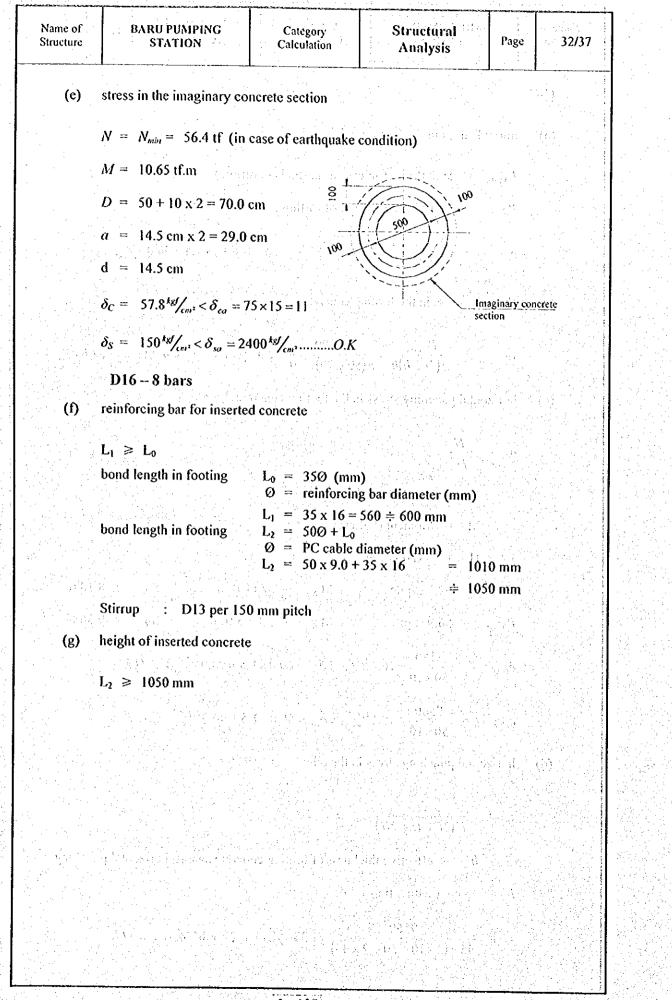
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StructureBARU PUMPING
STATIONCategory
CateulationStructural
AnalysisPage31/37C-C(a) normal stress in the footing concrete
$$P_{Nmax} = 59.2$$
 tifpile (in case of normal condition) $P_{Nmax} = 62.1$ tifpile (in case of earthquake condition) $\delta_{cr} = \frac{P_{Nmax}}{\pi w_A^2} = \frac{62100}{4} = 31.6^{10} f_{em}^4 < \delta_{em} = 60.0 \times 1.5 = 90.0^{16} f_{em}^4$ (b) shearing stress in the footing concrete $\tau_{\Gamma} = \frac{P_{Nmax}}{\pi (D+h)h} = \frac{62100}{\pi (50+70) \times 70} = 2.4^{16} f_{em}^4 < rea = 8.8^{16} f_{em}^4$ (c) horizontal punching stress in the footing concrete $\delta_{ch} = \frac{H}{D\ell}$ L = inserted pile length (cm)M = Moment (kgf.cm)11 - Axial Force $P_{Nmax} = 56.9$ tifpile $M_{X} = 9.11$ tfm $S_{AN} = \frac{8180}{50 \times 10} = 16.4^{16} f_{em}^{1/2} < \delta_{em} = 60.0 \times 1.5 = 90.0^{16} f_{em}^{1/2}, \dots O.K$ $\delta_{ch,Z} = \frac{9560}{50 \times 10} = 10.1^{16} f_{em}^{1/2} < \delta_{em} = 60.0 \times 1.5 = 90.0^{16} f_{em}^{1/2}, \dots O.K$ $\delta_{ch,Z} = \frac{9560}{50 \times 10} = 19.1^{16} f_{em}^{1/2} < \delta_{em} = 60.0 \times 1.5 = 90.0^{16} f_{em}^{1/2}, \dots O.K$ (d) horizontal punching stress in the pile $\tau_h = \frac{H}{H(2t+D+2H)}$ $h' = cflective thickness of footing concrete against horizontal punching $h' = 45$ cm (2 direction) $\tau_h = \frac{9560}{45 \times (2 \times 10 + 50 + 2 \times 45)} = 1.33^{16} f_{em}^{1/2} < \tau_{ch} = 8.8^{16} f_{em}^{1/2}, \dots O.K$$

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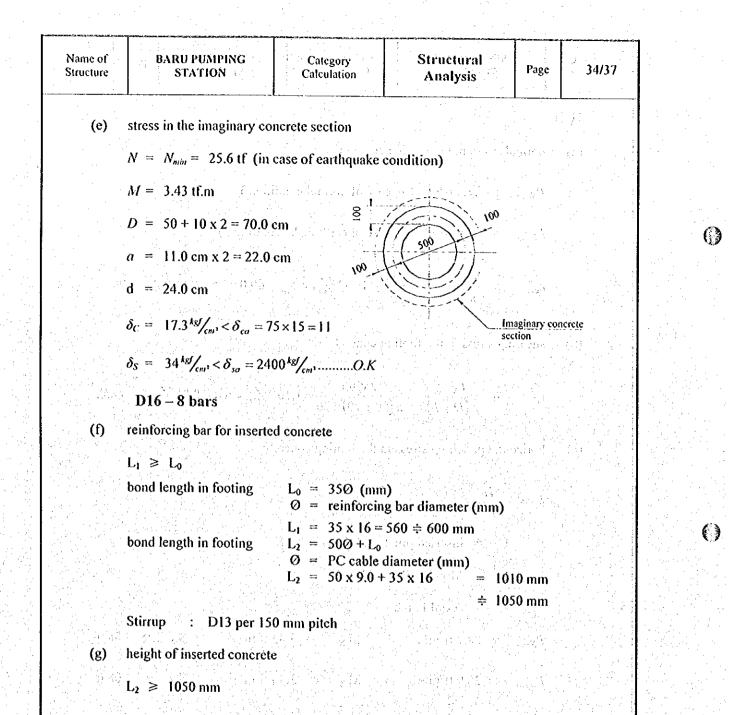
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Name of
StructureASIN PUMPING
STATIONCategory
CatedationStructural
AnalysisPage38/42**H-H**(a) normal stress in the footing concrete
$$P_{Near} = 27.2$$
 tf/pile (in case of normal condition) $P_{Near} = 28.9$ tf/pile (in case of carthquake condition) $P_{Near} = 28.9$ tf/pile (in case of carthquake condition) $P_{Near} = 28.9$ tf/pile (in case of carthquake condition) $\delta_{cr} = \frac{P_{Near}}{\pi D_{f}'} = \frac{28900}{4 \times 50^2} = 14.7^{16} f_{ear}' < \delta_{cu} = 60.0 \times 1.5 = 90.0^{16} f_{ear}'$ (b) shearing stress in the footing concrete $\tau_r = \frac{P_{Near}}{\pi (D + h)_h} = \frac{28900}{\pi (50 + 70) \times 70} = 1.10^{16} f_{ear}' < rea = 3.8^{16} f_{ear}'$ (c) horizontal punching stress in the footing concrete $\delta_{ds} = \frac{H}{D\ell}$ $\ell =$ inserted pile length (cm)M = Moment (kgf.cm)II - Axial Force $P_{Near} = 28.7$ tf/pile $M_X = 3.43$ tf.m $S_X = 3.08$ tf $\delta_{dsX} = \frac{3.080}{50 \times 10} = 6.2^{16} f_{ear}' < \delta_{ear} = 60.0 \times 1.5 = 90.0^{16} f_{ear}'.....O.K$ (d) horizontal punching stress in the pile $t_{t} = \frac{H}{H(2\ell + D + 2H)}$

h' = effective thickness of footing concrete against horizontal punching

h' = 45 cm (z direction)

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3.11 Safety Against Buoyancy

Safety against buoyancy was calculated as follows:

Safety Against Uplift (Baru)

	weight of structures (I)					
Name of Structure	civil structure	machien and others	total	uplift (l)	safety factor	
Front Structure	614.7	90.5	705.2	415.4	1.70	
Main Structure A	662.8	35.7	698.5	508.3	1.37	
Main Structure B	352.6	181.9	534.5	152.6	3.50	
Main Structure-C	378.7	131.6	510.3	27.3	18.69	

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