4.1.9 SUBSTRUCTURE (BRIDGE SPAN 31.0M)

Case-2: Bridge Width = 16.0 m

Bridge Width = 9.0 m

Bridge Width = 7.0 m

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Span Width

31.00 16.0 m

SUB STRUCTURE

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II SUB STRUCTURE
II.1 ABUTMENT
II.1.1 Neutral axis

depth of abutment = Ht			=	7.50	m							
depth beam			=	1.60	m							
depth slab			=	0.245	m							
depth of beam to deck			=	1.845	m							
depth of beam and deck			=	1.600	+	0.245	=	1.845	m			
depth bearing pad							=	0.100	m			
depth back wall			=	1.845	+	0.100	=	1.945	m			
depth of footing			=	1.000	m							
depth of steam			=	7.500	–	1.945	–	1.000	=	4.555	m	
	H1		=	1.945	m	W1	=	0.300	m			
	H2		=	4.555	m	Wf1	=	2.300	m			
	H3		=	1.000	m	Wf2	=	1.000	m			
	Ht		=	7.500	m	Wf3	=	1.800	m			
			=			W3	=	5.100	m			
Depth of back fill			=	7.500	–	1.000	=	6.500	m			
	H4		=	0.500	m	W4	=	0.550	m			
	H5		=	0.250	m	W5	=	0.550	m			
	H6		=	0.500	m	W6	=	0.200	m			
	H7		=	0.250	m	W7	=	0.200	m			
	H8		=	0.300	m	W8	=	0.300	m			
	H9		=	0.300	m	W9	=	1.800	m			

A1	W1	=	0.300	X1 =	W1/2	+	W2	+	Wf3					
					0.150	+	1.000	+	1.800		=	2.950	m	
	H1	=	1.945	Y1=	Ht	–	H1/2							
					7.500	–	0.973				=	6.528	m	
A2	W2	=	1.000	X2 =	W2/2	+	Wf3							
					0.500	+	1.800				=	2.300	m	
	H2	=	4.555	Y2=	H2/2	+	H3							
					2.278	+	1.000				=	3.278	m	
A3	W3	=	5.100	X3 =	W3/2									
					2.550						=	2.550	m	
	H3	=	1.000	Y3=	H3/2									
					0.500						=	0.500	m	
A4	W4	=	0.550	X4 =	W4/2	+	W2	+	Wf3					
					0.275	+	1.000	+	1.800		=	3.075	m	
	H4	=	0.500	Y4=	H2	–	H4/2	+	H3					
					4.555	–	0.500	+	1.000		=	5.055	m	
A5	W5	=	0.550	X5 =	W5/3	+	W2	+	Wf3					
					0.183	+	1.000	+	1.800		=	2.983	m	
	H5	=	0.250	Y5=	H2	–	H4/2	–	H5/3	+ H3				
					4.555	–	0.250	–	0.083	+ 1.000	=	5.222	m	
A6	W6	=	0.200	X6 =	Wf3	–	W6/2							
					1.800	–	0.100				=	1.700	m	
	H6	=	0.500	Y6=	H2	–	H6/2	+	H3					
					4.555	–	0.250	+	0.083		=	4.388	m	
A7	W7	=	0.200	X7 =	Wf3	–	W7/3							
					1.800	–	0.067				=	1.733	m	
	H7	=	0.250	Y7=	H2	–	H6/2	–	H7/3	+ H3				
					4.555	–	0.250	–	0.083	+ 1.000	=	5.222	m	
A8	W8	=	2.300	X8 =	W8/3	+	Wf2	+	Wf3					
					0.767	+	1.000	+	1.800		=	3.567	m	
	H8	=	0.300	Y8=	H8/3	+	H3							
					0.100	+	1.000				=	1.100	m	
A9	W9	=	1.800	X9 =	W9x2/3									
					1.200						=	1.200	m	
	H9	=	0.300	Y9=	H9/3	+	H3							
					0.100	+	1.000				=	1.100	m	

ar–xy

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II SUB STRUCTURE
II.1 ABUTMENT
II.1.1 Neutral axis

Wing wall

Hgw	=	1.200	m	H back fill	=	6.50	m
Ww1	=	3.00	m	Hw1	=	3.00	m
Ww2	=	2.30	m	Hw2	=	1.00	m
Ww3	=	0.70	m	Hw3	=	1.00	m
Ww4	=	2.30	m	Hw4	=	2.20	m
Ww5	=	2.30	m	Hw5	=	0.30	m

Ww1	Ww1	=	3.000	Xw1=	Ww1/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800		=	4.300	m	
	Hw1	=	3.000	Yw1=	Ht	–	Hw1/2							
					7.500	–	1.500				=	6.000	m	
Ww2	Ww2	=	2.300	Xw2=	Ww2/2	+	W2	+	Wf3					
					1.150	+	1.000	+	1.800		=	3.950	m	
	Hw2	=	1.000	Yw2=	Ht	–	Hw1	–	Hw2/2					
					7.500	–	3.000	–	0.500		=	4.000	m	
Ww3	Ww3	=	0.700	Xw3=	W3	–	Ww3/2							
					5.100	–	0.350				=	4.750	m	
	Hw3	=	1.000	Yw3=	Ht	–	Hw1	–	Hw3/2					
					7.500	–	3.000	–	0.333		=	4.167	m	
Ww4	Ww4	=	2.300	Xw4=	Ww4/2	+	W2	+	Wf3					
					1.150	+	1.000	+	1.800		=	3.950	m	
	Hw4	=	2.200	Yw4=	Hw4/2	+	Hw5	+	H3					
					1.100	+	0.300	+	1.000		=	2.400	m	
Ww5	Ww5	=	2.300	Xw5=	W3	–	Ww5x2/3							
					5.100	–	1.533				=	3.567	m	
	Hw5	=	0.300	Yw5=	Hw5/3	+	H3							
					0.100	+	1.000				=	1.100	m	

Guide wall

Gw	Wgw	=	3.000	Xgw=	Wgw/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800		=	4.300	m	
	Hgw	=	1.200	Ygw=	Ht	+	Hgw/2							
					7.500	+	0.600				=	8.100	m	

Approach slab

Apr	Wapr	=	3.000	Xapr=	Wapr/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800		=	4.300	m	
	Hapr	=	0.200	Yapr=	Ht	–	H1	+	Hapr/2					
					7.500	–	1.945	+	0.100		=	5.655	m	

Asphalt

Ha = 0.05 m

Asp	Wasp	=	3.000	Xasp=	W9/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800		=	4.300	m	
	Hasp	=	0.050	Yasp=	Ht	–	Hasp/2							
					7.500	–	0.025				=	7.475	m	

Back fill HWL

a. In case High Water Level

Top deck elvation	=	39.900	m				
Hwl elvation	=	32.050	m				
Lwl elvation	=	28.180	m				
Base foting elv.	=	39.900	–	7.500	=	32.400	m
Top foting elv.	=	32.400	+	1.000	=	33.400	m
Depth of wet soil H wet.l	=	39.900	–	32.050	=	7.850	m under footing
H wet.l	=	39.900	–	33.400	=	6.500	m
H wet.r	=	H wet.l	–	Ht			
	=	6.500	–	1.945	=	4.555	m

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Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – MF5 Station : Fw 36 + 65	Japan International Cooperation Agency	Calculation sheet Date Nos of sheet Prepared by

II SUB STRUCTURE
II.1 ABUTMENT
II.1.1 Neutral axis

Depth of saturated soil = H sat.l

H sat.l = 6.500 − 6.500 = 0.000 m

a.1 In case High Water Level

a.1 soil wet condition

wet.l	Wwet.l	=	2.300	X1 =	Wwet.l/2	+	W2	+	Wf3		
					1.150	+	1.000	+	1.800	=	3.950 m
	Hwet.l	=	6.500	Y1 =	Ht	−	Hwet.l/2				
					7.500	−	3.250			=	4.250 m
wet.r	Wwet.r	=	1.800	X2 =	Wf3/2						
					0.900					=	0.900 m
	Hwet.r	=	4.555	Y2 =	Hwet.r/2	+	H3				
					2.278	+	1.000			=	3.278 m

a.2 soil saturated condition

sat.l	Wsat.l	=	2.300	X1 =	Wsat.l/2	+	W2	+	Wf3		
					1.150	+	1.000	+	1.800	=	3.950 m
	Hsat.l	=	0.000	Y1 =	Hsat.l/2	+	H3				
					0.000	+	1.000			=	1.000 m
sat.r	Wsat.r	=	1.800	X2 =	Wsat.r/2						
					0.900					=	0.900 m
	Hsat.r	=	0.000	Y2 =	Hsat.r/2	+	H3				
					0.000	+	1.000			=	1.000 m

b. In case Low Water Level

b.1 soil wet condition

Depth of wet soil = Hwet

H wet = 39.900 − 33.400 = 6.500 m

Depth of saturated soli HWL = Hstr

Hsat = 6.500 − 6.500 = 0.000 m

Depth of back fill Rs = Hwc elv − Top foooting elv.

= 37.955 − 33.400

= 4.555 m

wet.l	Wwet.l	=	2.300	X1 =	Wwet.l/2	+	W2	+	Wf3		
					1.150	+	1.000	+	1.800	=	3.950 m
	Hwet.l	=	6.500	Y1 =	Hwet.l/2	+	H3				
					3.250	+	1.000			=	4.250 m
wet.r	Wwet.r	=	1.800	X2 =	Wwet.r/2						
					0.900					=	0.900 m
	Hwet.r	=	4.555	Y2 =	Hwet.r/2	+	H3				
					2.278	+	1.000			=	3.278 m

b.2 soil saturated condition

sat.l	Wsat.l	=	2.300	X1 =	Wsat.l/2	+	W2	+	Wf3		
					1.150	+	0.000	+	0.000	=	1.150 m
	Hsat.l	=	0.000	Y1 =	Hsat.l/2	+	H3				
					0.000	+	H3			=	0.000 m
sat.r	Wsat.r	=	1.800	X2 =	Wsat.r/2						
					0.900					=	0.900 m
	Hsat.r	=	0.000	Y2 =	Hsat.r/2	+	H3				
					0.000	+	0.200			=	0.200 m

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Project : Medan Flood Control Channel : Medan Flood Way Structur : Br – F5 Station : Fw 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II.1.2 Axial load to Abutment

a. Superstucture

Vertical load/m'

Skew angle = 43.90 degree

alpha = 0.693 degree

Length of Abutment = 19.00 m

Depth of Abutment = 7.50 m

Width of footing = 5.10 m

Skew Length of Abutment = 27.40 m

Width of footing = 10.82 m

Vertical load on abutment :

	Dead load ton	Line load ton	Uniform load ton	Pedestrian load ton	= Total ton
weight	932.63	54.55	307.42	18.60	= 1,313.20
per Abt.	466.32	27.28	153.71	9.30	= 656.60
per m'	17.018	0.995	5.610	0.339	= 23.963

Siesmic coefficient = 0.18

Horizontal load

Heq = 0.180 x Rdl

= 0.180 x 17.018

= 3.063 ton/m'

Acting point of siesmic load

Wf3 = 1.80 m

H3 = 1.00 m

X = 0.300 + WF3

= 0.300 + 1.80

= 2.100 m

Y = H2 + H3

= 4.555 + 1.00

= 5.555 m

b. Abutment section

Self weight

Section	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
A1	0.30	1.595	1.00	1.00	2.40	1.148	1.148	2.950	6.528	3.388	3.388
A2	1.00	4.555	1.00	1.00	2.40	10.932	10.932	2.300	3.278	25.144	25.144
A3	5.10	1.000	1.00	1.00	2.40	12.240	12.240	2.550	0.500	31.212	31.212
A4	0.55	0.500	1.00	1.00	2.40	0.660	0.660	3.075	5.055	2.030	2.030
A5	0.55	0.250	1.00	1.00	2.40	0.165	0.165	2.983	5.222	0.492	0.492
A6	0.20	0.500	1.00	1.00	2.40	0.240	0.240	1.700	4.388	0.408	0.408
A7	0.20	0.500	1.00	1.00	2.40	0.120	0.120	1.733	5.222	0.208	0.208
A8	2.30	0.300	1.00	1.00	2.40	0.828	0.828	3.567	1.100	2.953	2.953
A9	1.80	0.300	1.00	1.00	2.40	0.648	0.648	1.200	1.100	0.778	0.778
					sum		26.981			66.61	66.61

Wing wall and guard wall

Ww1	3.000	3.000	0.40	2.00	2.400	0.909	0.048	4.300	6.000	0.206	0.206
Ww2	2.300	1.000	0.40	2.00	2.400	0.232	0.012	3.950	4.000	0.048	0.049
Ww3	0.400	1.000	0.40	2.00	2.400	0.040	0.002	4.750	4.167	0.010	0.009
Ww4	2.300	2.200	0.40	2.00	2.400	0.511	0.027	3.950	2.400	0.106	0.065
Ww5	2.300	0.300	0.40	2.00	2.400	0.070	0.004	3.567	1.100	0.013	0.004
Gw	3.00	1.200	0.40	2.00	2.000	0.303	0.016	4.300	6.100	0.069	0.129
					sum		0.093			0.384	0.332

Miscellaneous load

Aproaach Road,Guide wall and Asphalt

Aps	3.00	0.20	1.00	1.00	2.400	1.44	1.440	4.300	5.655	6.192	8.143
asp	3.00	0.05	1.00	1.00	2.300	0.35	0.345	4.300	7.475	1.483	2.579
					sum		1.785			7.675	10.722
					total		28.859			74.67	77.67

axl-lod

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel : Medan Flood Way		Date
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II.1.2 Axial load to Abutment

Centre of gravity

$$X = \frac{Gv/m'.X}{Gv/m'} = \frac{74.671}{28.859} = 2.587 \text{ m}$$

$$Y = \frac{Gv/m'.Y}{Gv/m'} = \frac{77.666}{28.859} = 2.691 \text{ m}$$

H – Abt. = 0.180 x 28.859 = 5.195 ton

c. Back fill

a. Incase High Water level

Depth of back fill = 6.500 m
H wet = 6.500 m
H saturated = 0.000 m

Sec-tion	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	6.500	1.00	1.00	1.850	27.658	27.658	3.950	4.595	109.25	127.09
Wet.r	1.800	4.555	1.00	1.00	1.850	15.168	15.168	0.900	3.278	13.65	49.72
Sat.l	2.300	0.000	1.00	1.00	2.000	0.000	0.000	3.950	1.000	0.000	0.000
Sat.r	1.800	0.000	1.00	1.00	2.000	0.000	0.000	0.900	1.000	0.000	0.000
				sum			42.826			********	176.807

$$X = \frac{Gv/m'.X}{Gv/m'} = \frac{********}{42.826} = 2.870 \text{ m}$$

$$Y = \frac{Gv/m'.Y}{Gv/m'} = \frac{176.807}{42.826} = 4.129 \text{ m}$$

H – Abt. = 0.180 x 42.826 = 7.709 ton

b. Low water level

Depth of H wet = 6.500 m
Depth of H saturated = 0.00 m

a. Wet condition

Sec-tion	width m	depth m	length m	nos	Yo t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	6.500	1.00	1.00	1.850	27.658	27.658	3.950	4.250	********	117.544
Wet.r	1.800	4.555	1.00	1.00	1.850	15.168	15.168	0.900	3.278	13.651	49.721
Sat.l	2.300	0.000	1.00	1.00	1.850	0.000	0.000	1.150	0.000	0.000	0.000
Sat.r	1.800	0.000	1.00	1.00	1.850	0.000	0.000	0.900	0.000	0.000	0.000
				sum			42.826			********	167.266

Habt 0.180 x 42.826 = 7.709 ton

Centre of gravity

$$X = \frac{Gv/m'.X}{Gv/m'} = \frac{********}{42.826} = 2.870 \text{ m}$$

$$Y = \frac{Gv/m'.Y}{Gv/m'} = \frac{167.266}{42.826} = 3.906 \text{ m}$$

axl-fod

Project : Medan Flood Cont	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel : Flood Way		Date
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Station : FW 33 + 65		Prepared by

II.1.3 Columb's coefficient

Right side Abutment

Normal condition

ø	=	30.00 deg.	ø – alpa	=	30.00 – 0.0	=	30.00 deg.
alpa	=	0.0 deg.	ø + delta	=	30.00 + 30.00	=	60.00 deg.
Q	=	0.0 deg.	ø – beta	=	30.00 – 0.0	=	30.00 deg.
delta	=	30.00 deg.	alpa + delta	=	0.0 + 30.00	=	30.00 deg.
beta	=	0.0 deg.	alpa – beta	=	0.0 – 0.000	=	0.00 deg.

$$Ka = \frac{\text{Cos}^2(ø - \text{alpa})}{\text{Cos}^2\text{alpa}.\cos(\text{alpa} + \text{delta}).\{(1 + @\text{sqrt}(\frac{\sin(ø + \text{delta}).(\sin(Ø - \text{beta})}{\cos(\text{alpa} + \text{delta}).\cos(\text{alpa} - \text{beta})}))\}^2}$$

Cos(alpa)	=	1.000	sin(ø + delta)	=	0.866
Cos^2 (alpa)	=	1.000	sin(ø – beta)	=	0.500
Cos(ø – alpa)	=	0.866	cos(alpa + delta)	=	0.866
Cos^2 (ø – alpa)	=	0.750	cos(alpa – beta)	=	1.000

A = sin(ø+delta).sin(ø–beta) = 0.866 x 0.500 = 0.433

B = cos (alpa + delta).cos(alpa–beta) = 0.866 + 1.000 = 0.866

C = cos^2 (alpa).cos(alpa+delta) @sqrt(A/B) = 0.71
= 1.000 x 0.866
= 0.866

D = (1 + @sqrt(A/B)^2 C.D = 0.866 x 2.914
= (1.000 + 0.707)^2 = 2.524
= 2.914

$$Ka = \frac{\text{Cos}^2(ø-\text{alpa})}{C.D} = \frac{0.75}{2.52} = 0.297$$

Earth quake condition

$$Ke = \frac{\text{Cos}(ø - \text{alpa} - Qo)^2}{\text{Cos}\,Qo.\text{Cos}^2\text{alpa}.\cos(\text{alpa} + \text{delta}^{\wedge} + Qo).\{(1 + @\text{sqrt}(\frac{\sin(ø + \text{delta}).(\sin(Ø - \text{beta} - Qo)}{\cos(\text{alpa} + \text{delta} + Qo).\cos(\text{alpa} - \text{beta})}))}$$

Qo = composite siesmic angle

$$k' = \tan^{-1}k = \frac{Y}{Y-1} \times k$$

k = siesmic coefficient in air
= 0.15

Y = 2.00

Y – 1 = 1.00

$$k' = \frac{Y}{Y-1} \times k$$

$$= \frac{2.00}{1.00} \times 0.15$$

= 0.30

Qo = @atan^-1.k
Qo = 8.5308

colum

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II.1.3 Columb's coefficient

ø	=	30.00	deg.	ø – alpa–Qo	=	30.00	– 0.00	– 8.53	=	21.47
alpa	=	0.00	deg.	ø + delta	=	30.00	+ 15.00		=	45.00
Q	=	8.53	deg.	ø – beta–Qo	=	30.00	– 0.00	– 8.53	=	21.47
delta	=	15.00	deg.	ø – beta + Qo	=	30.00	– 0.00	+ 8.53	=	38.53
beta	=	0.00	deg.	alpa + delta+Qo	=	0.00	+ 15.00	+ 8.53	=	23.53
				alpa – beta	=	0.000	– 0.000		=	0.00
Cos(Qo)	=	0.989								
Cos(alpa)	=	1.000		sin(ø + delta)	=	0.707				
Cos ^ 2 (alpa)	=	1.000		sin(ø – beta – Q	=	0.366				
Cos(ø – alpa – Qo)	=	0.931		cos(alpa + delta +	=	0.917				
Cos ^ 2 (ø – alpa–Qo) ^ 2	=	0.866		cos(alpa – beta)	=	1.000				

A = sin(ø+delta).sin(ø–beta–Qo)
= 0.707 x 0.366
= 0.259

B = cos (alpa + delta+Qo).cos(alpa–beta)
= 0.917 + 1.000
= 0.917

C = cos Qo.Cos ^ 2(alpa).cos(alpa+delta+Qo)
= 0.989 x 1.000 x 0.92
= 0.907

@sqrt(A/B) = 0.531

D = (1 + @sqrt(A/B) ^ 2
= (1.000 + 0.531) ^ 2
= 2.345

C.D = 0.907 x 2.345
= 2.126

$$Ke = \frac{Cos^2(\phi - alpa)}{C.D} = \frac{0.87}{2.126} = 0.407$$

colum

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Flood Way		Date	
Structure	: Br – MF5		Nos of sheet	
Station	: FW 33 + 65		Prepared by	

II.1.4 Lateral earth pressure due to earthquake

Kh = C x I x S

Kh = coefficient of horizontal siesmic loading

C = the base shear coefficient,base on the data :
siesmic zone and soil condition

Siesmic zone = 4

soil condition soft soi C = 0.15

S = the structure type factor = 1

I = the importance factor

for bridge carrying more than 2.000 vehicle per day

I = 1.2

C	I	S	kh
0.15	1.2	1	0.18

for all other permanent bridge

I = 1

C	I	S	kh
0.15	1	1	0.15

for temporary bridge

I = 0.8

C	I	S	kh
0.15	0.8	1	0.12

soil condition firm soi C = 0.10

for bridge carrying more than 2.000 vehicle per day

C	I	S	kh
0.1	1.2	1	0.12

for all other permanent bridge

C	I	S	kh
0.1	1.00	1	0.10

for temporary bridge

C	I	S	kh
0.1	0.8	1	0.08

source,Bridge Management System

EQ

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – MF5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

II.1.5 Horizontal force at Abutment
Normal Condition
II.1.5.1 Case – I. High Water Level

Depth of abutment	=	7.50	m				
Surcharge load	=	1.00	t/m2				
Unit weight wet soil	=	1.85	t/m3				
Unit weight saturated soil	=	2.00	t/m3				
Unit weight of water	=	1.00	t/m3				
Width of footing							
Wf1	=	2.30	m				
Wf2	=	1.00	m				
Wf3	=	1.80	m				
W3	=	5.10	m				
Top slab elevation	=	39.900	m				
Elevation of LWL	=	28.180	m				
Elevation of HWL	=	32.050	m				
Depth of footing	=	1.000	m				
Elv.of base footing	=	39.900	–	7.50	=	32.400	m
Elv.of top footing	=	32.400	+	1.00	=	33.400	m
Depth of back fill	=	39.900	–	33.400	=	6.500	m
Depth of wet soil	=	H wet					
H wet	=	39.900	–	32.050	=	7.850	m under footing
H wet	=	39.900	–	33.400	=	6.500	m
Depth of saturated soil	=	H sat					
H sat	=	6.50	–	6.500	=	0.000	m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	1.000	t/m2	Sin(alpha)	=	0.000
delta	=	0.000		L	=	1.000 m
alpa	=	0.000		H	=	7.500 m
Cos(alph	=	1.000		B	=	5.100 m

oefficient of active pressure Ka = 0.297

Pq = q x H x L x Ka
Pq = 1.000 x 6.500 x 1.000 x 0.297
Pq = 1.930 ton

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x Cos(alpha)
	=	1.930	x	0.000		=	1.930	x 1.000
	=	0.000 ton				=	1.930	ton
X	=	5.100	m		Y	=	6.500	: 2.000
						=	3.250	m

B By earth
B–1 Wet soil
Ht = 6.500 m
Hwet = 6.500 m
Hsat = 0.000 m

fh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – MF5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

II.1.5 Horizontal force at Abutment
Normal Condition
II.1.5.1 Case – I. High Water Level

1. Load trianngular

Pw = 0.500 x Ywet x Hwet^2 x L x Ka
Pw = 0.500 x 1.850 x 42.250 x 6.500 x 0.297
Pw = 75.446 ton

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)
	=	75.446	x	0.000		=	75.446	x	1.000
	=	0.000	ton			=	75.446	ton	
X	=	5.100	m		Y	=	6.500	: 3.000	+ 0.000
						=	2.167	m	

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ka
Ps1 = 2.000 x 0.000 x 1.000 x 0.297
Ps1 = 0.000 ton

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x	Cos(alpha)
	=	0.000		0.000		=	0.000	x	1.000
	=	0.000	ton			=	0.000	ton	
X	=	5.100	m		Y	=	0.000	: 2.000	
						=	0.000	m	

3. Load trianngular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ka
Ps2 = 0.500 x 2.000 x 0.000 x 1.000 x 0.297
Ps2 = 0.000 ton

Ps2(v)	=	H sat–2	x	Sin(alpha)	Ps2(h)	=	H sat–2	x	Cos(alpha)
	=	0.000	x	0.000		=	0.000	x	1.000
	=	0.000	ton			=	0.000	ton	
X	=	5.100	m		Y	=	0.000	: 3.000	
						=	0.000	m	

4. Water

Hw = 0.000 m

Pw in = 0.500 x Yw x Hw^2 x L
Pw in = 0.500 x 1.000 x 0.000 x 1.000
Pw in = 0.000 ton

X = 5.100 m
Y = 0.000 : 3.000
= 0.000 m

Hw = 0.000 m

Pw out = 0.500 x Yw x Hw^2 x L
Pw out = 0.500 x 1.000 x 0.000 x 1.000
Pw out = 0.000 ton

X = 0.500 m
Y = 0.000 : 3.000
= 0.000 m

fh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – MF5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

II.1.5 Horizontal force at Abutment
Normal Condition
II.1.5.1 Case – I, High Water Level

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x Yw	
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100	:	2.000		
	=	2.550	m			

fh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – MF5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

Normal Condition
II.1.5.2 Case – II, Low Water Level

Depth of abutment	=	7.50	m				
Surcharge load	=	1.00	t/m2				
Unit weight wet soil	=	1.85	t/m3				
Unit weight saturated soil	=	2.00	t/m3				
Unit weight of water	=	1.00	t/m3				
Width of footing							
Wf1	=	2.30	m				
Wf2	=	1.00	m				
Wf3	=	1.80	m				
W3	=	5.10	m				
Top slab elevation	=	39.900	m				
Elevation of LWL	=	28.180	m				
Elevation of HWL	=	32.050	m				
Depth of footing	=	1.000	m				
Elv.of base footing	=	39.900	–	7.50	=	32.400	m
Elv.of top footing	=	32.400	+	1.00	=	33.400	m
Depth of back fill	=	39.900	–	33.400	=	6.500	m
Depth of wet soil	=	H wet					
H wet	=	39.900	–	28.180	=	11.720	m under footing
H wet	=	39.900	–	33.400	=	6.500	m
Depth of saturated soil	=	H sat					
H sat	=	6.50	–	6.500	=	0.000	m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.500	m
Cos(alph	=	1.000	B	=	5.100	m

oefficient of active pressure Ka = 0.297

Pq = q x H x L x Ka
Pq = 1.000 x 6.500 x 1.000 x 0.297
Pq = 1.930 ton

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x Cos(alpha)
	=	1.930	x	0.000		=	1.930	x 1.000
	=	0.000 ton				=	1.930	ton
X	=	5.100	m		Y	=	6.500	: 2.000
						=	3.250	m

B By earth

B–1 Wet soil

Ht = 6.500 m
Hwet = 6.500 m
Hsat = 0.000 m

fh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – MF5		Nos of sheet
Station	: Fw 33 + 65		Prepared by

Normal Condition
II.1.5.2 Case – II, Low Water Level

1. Load trianngular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x	Ka
	=	0.500	x	1.850	x	42.250	x	1.000	x	0.297
	=	11.607	ton							

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)	
	=	11.607	x	0.000		=	11.607	x	1.000	
	=	0.000	ton			=	11.607	ton		
X	=	5.100	m		Y	=	6.500	:	3.000	+ 0.000
						=	2.167	m		

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L	x Ka
	=	2.000	x	0.000	x	1.000	x 0.297
	=	0.000	ton				

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x	Cos(alpha)
	=	0.000		0.000		=	0.000	x	1.000
	=	0.000	ton			=	0.000	ton	
X	=	5.100	m		Y	=	0.000	:	2.000
						=	0.000	m	

3. Load trianngular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x Ka
	=	0.500	x	2.000	x	0.000	x	1.000	x 0.297
	=	0.000	ton						

Ps2(v)	=	H sat–2	x	Sin(alpha)	Ps2(h)	=	H sat–2	x	Cos(alpha)
	=	0.000	x	0.000		=	0.000	x	1.000
	=	0.000	ton			=	0.000	ton	
X	=	5.100	m		Y	=	0.000	:	3.000
						=	0.000	m	

4. Water

Hw = 0.000 m

Pw in	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000	ton					
X	=	5.100	m					
Y	=	0.000	:	3.000				
	=	0.000	m					

Hw = 0.000 m

Pw out	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000	ton					
X	=	0.500	m					
Y	=	0.000	:	3.000				
	=	0.000	m					

fh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – MF5		Nos of sheet
Station	: Fw 33 + 65		Prepared by

Normal Condition
II.1.5.2 Case – II, Low Water Level

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw
	=	0.000	x	5.100	x	1.000
	=	0.000	ton/m'			
X	=	5.100	:	2.000		
	=	2.550	m			

fh–1

Project	: Medan Flood Control	Japan International	Calculation sheet
Channel	: Medan Flood Way	Cooperation Agency	Date
Structure	: Br – MF5	(JICA)	Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.3 Case – III, Low Water Level

Depth of abutment	=	7.50	m				
Surcharge load	=	0.50	t/m2				
Unit weight wet soil	=	1.85	t/m3				
Unit weight saturated soil	=	2.00	t/m3				
Unit weight of water	=	1.00	t/m3				
Width of footing							
Wf1	=	2.30	m				
Wf2	=	1.00	m				
Wf3	=	1.80	m				
W3	=	5.10	m				
Top slab elevation	=	39.900	m				
Elevation of LWL	=	28.180	m				
Elevation of HWL	=	32.050	m				
Depth of footing	=	1.000	m				
Elv.of base footing	=	39.900	–	7.50	=	32.400	m
Elv.of top footing	=	32.400	+	1.00	=	33.400	m
Depth of back fill	=	39.900	–	33.400	=	6.500	m
Depth of wet soil	= H wet						
H wet	=	39.900	–	32.050	=	7.850	m under footing
H wet	=	39.900	–	33.400	=	6.500	m
Depth of saturated soil	= H sat						
H sat	=	6.50	–	6.500	=	0.000	m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	0.500 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.500	m
Cos(alph	=	1.000	B	=	5.100	m

oefficient of active pressure Ke = 0.407

Pq = q x H x L x Ke
Pq = 0.500 x 6.500 x 1.000 x 0.407
Pq = 1.323 ton

Pqv	=	Hq	x Sin(alpha)	Pqh	=	Hq	x Cos(alpha)
	=	1.323	x 0.000		=	1.323	x 1.000
	=	0.000 ton			=	1.323	ton
X	=	5.100 m		Y	=	6.500	: 2.000
					=	3.250	m

B By earth
B–1 Wet soil
Ht = 6.500 m
Hwet = 6.500 m
Hsat = 0.000 m

fh–3

Project	: Medan Flood Control	Japan International	Calculation sheet
Channel	: Medan Flood Way	Cooperation Agency	Date
Structure	: Br – MF5	(JICA)	Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.3 Case – III, Low Water Level

1. Load trianngular

Pw = 0.500 x Ywet x Hwet^2 x L x Ke
Pw = 0.500 x 1.850 x 42.250 x 1.000 x 0.407
Pw = 15.906 ton

Pw(v)	=	Pw	x Sin(alpha)	Pw(h)	=	Pw x Cos(alpha)
	=	15.906	x 0.000		=	15.906 x 1.000
	=	0.000 ton			=	15.906 ton
X	=	5.100 m		Y	=	6.500 : 3.000 + 0.000
					=	2.167 m

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ke
Ps1 = 2.000 x 0.000 x 1.000 x 0.407
Ps1 = 0.000 ton

Ps1(v)	=	H sat	x Sin(alpha)	Ps1(h)	=	H sat x Cos(alpha)
	=	0.000	0.000		=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 2.000
					=	0.000 m

3. Load trianngular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ke
Ps2 = 0.500 x 2.000 x 0.000 x 1.000 x 0.407
Ps2 = 0.000 ton

Ps2(v)	=	H sat–2	x Sin(alpha)	Ps2(h)	=	H sat–2 x Cos(alpha)
	=	0.000	x 0.000		=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 3.000
					=	0.000 m

4. Water

Hw = 0.000 m

Pw in	=	0.500	x Yw	x Hw^2	x	L
	=	0.500	x 1.000	x 0.000	x	1.000
	=	0.000 ton				
X	=	5.100 m				
Y	=	0.000	: 3.000			
	=	0.000 m				

Hw = 0.000 m

Pw out	=	0.500	x Yw	x Hw^2	x	L
	=	0.500	x 1.000	x 0.000	x	1.000
	=	0.000 ton				
X	=	0.500 m				
Y	=	0.000	: 3.000			
	=	0.000 m				

fh–3

Project	: Medan Flood Control	Japan International	Calculation sheet
Channel	: Medan Flood Way	Cooperation Agency	Date
Structure	: Br – MF5	(JICA)	Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.3 Case – III, Low Water Level

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x Yw	
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100	:	2.000		
	=	2.550 m				

Project	: Medan Flood Control	Japan International	Calculation sheet
Channel	: Medan Flood Way	Cooperation Agency	Date
Structure	: Br – MF5	(JICA)	Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.4 Case – IV, Low Water Level

Depth of abutment	=	7.50 m					
Surcharge load	=	0.50 t/m2					
Unit weight wet soil	=	1.85 t/m3					
Unit weight saturated soil	=	2.00 t/m3					
Unit weight of water	=	1.00 t/m3					
Width of footing							
Wf1	=	2.30 m					
Wf2	=	1.00 m					
Wf3	=	1.80 m					
W3	=	5.10 m					
Top slab elevation	=	39.900 m					
Elevation of LWL	=	28.180 m					
Elevation of HWL	=	32.050 m					
Depth of footing	=	1.000 m					
Elv.of base footing	=	39.900	–	7.50	=	32.400	m
Elv.of top footing	=	32.400	+	1.00	=	33.400	m
Depth of back fill	=	39.900	–	33.400	=	6.500	m
Depth of wet soil	=	H wet					
H wet	=	39.900	–	28.180	=	11.720	m under footing
H wet	=	39.900	–	33.400	=	6.500	m
Depth of saturated soil	=	H sat					
H sat	=	6.50	–	6.500	=	0.000	m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	0.500 t/m2		Sin(alpha)	=	0.000
delta	=	0.000		L	=	1.000 m
alpa	=	0.000		H	=	7.500 m
Cos(alph	=	1.000		B	=	5.100 m

oefficient of active pressure Ke = 0.407

Pq	=	q	x	H	x	L	x Ke	
Pq	=	0.500	x	6.500	x	1.000	x	0.407
Pq	=	1.323 ton						

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x	Cos(alpha)
	=	1.323	x	0.000		=	1.323	x	1.000
	=	0.000 ton				=	1.323 ton		
X	=	5.100 m			Y	=	6.500	:	2.000
						=	3.250 m		

B By earth
B-1 Wet soil
Ht = 6.500 m
Hwet = 6.500 m
Hsat = 0.000 m

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – MF5		Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.4 Case – IV, Low Water Level

1. Load triangular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x	Ke
	=	0.500	x	1.850	x	42.250	x	1.000	x	0.407
	=	15.906	ton							

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)	
	=	15.906	x	0.000		=	15.906	x	1.000	
	=	0.000	ton			=	15.906	ton		
X	=	5.100	m		Y	=	6.500	:	3.000	+ 0.000
						=	2.167	m		

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L	x Ke
	=	2.000	x	0.000	x	1.000	x 0.407
	=	0.000	ton				

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x	Cos(alpha)
	=	0.000		0.000		=	0.000	x	1.000
	=	0.000	ton			=	0.000	ton	
X	=	5.100	m		Y	=	0.000	:	2.000
						=	0.000	m	

3. Load triangular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x	Ke
	=	0.500	x	2.000	x	0.000	x	1.000	x	0.407
	=	0.000	ton							

Ps2(v)	=	H sat–2	x	Sin(alpha)	Ps2(h)	=	H sat–2	x	Cos(alpha)	
	=	0.000	x	0.000		=	0.000	x	1.000	
	=	0.000	ton			=	0.000	ton		
X	=	5.100	m		Y	=	0.000	:	3.000	
						=	0.000	m		

4. Water

Hw = 0.000 m

Pw in	=	0.500	x	Yw	x	Hw^2	x	L	
	=	0.500	x	1.000	x	0.000	x	1.000	
	=	0.000	ton						
X	=	5.100	m						
Y	=	0.000	:	3.000					
	=	0.000	m						

Hw = 0.000 m

Pw out	=	0.500	x	Yw	x	Hw^2	x	L	
	=	0.500	x	1.000	x	0.000	x	1.000	
	=	0.000	ton						
X	=	0.500	m						
Y	=	0.000	:	3.000					
	=	0.000	m						

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – MF5		Nos of sheet
Station	: Fw 33 + 65		Prepared by

Earthquake condition
II.1.5.4 Case – IV, Low Water Level

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw	
	=	0.000	x	5.100	x	1.000	
	=	0.000	ton/m'				
X	=	5.100	:	2.000			
	=	2.550	m				

fh–4

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – MF5 Station : Fw 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II.1.6 Combined load on Abutment
Normal condition

II.1.6.1 Case – I, High Water Level

Skew angle		=	43.90	degree
sin alpha		=	0.693	degree
Length	L	=	19.00	m
Width of floting	W3	=	5.10	m
Thick of footing	H3	=	1.00	m
Skew length		=	27.40	m
Skew width of footing		=	7.36	m

	Item	V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
Super structure	V–sp	23.963		2.100		50.322	
Abutment	V–abt	28.859		2.587		74.658	
Back fill	V–bf	42.826		2.870		122.911	
			Active earth pressure				
Surcharge load	Pq		1.930		3.250		6.273
triangle load	Pw		11.607		2.167		25.152
rectangular load	Ps1						
triangle load	Ps2						
Water	Pw in						
	Pw out						
Up life	Pu						
	Total	95.648	13.537			247.891	31.425

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{247.891}{95.648} = 2.592\ m$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{31.425}{13.537} = 2.321\ m$$

V = V/m' x L
= 95.65 x 27.40
= 2,620.86 ton

H = H/m' x L
= 13.54 x 27.40
= 370.93 ton

M = V.(X–(0.5.W)) – H.(Y–tb)

0.5 x W	=	0.50	x	5.10
	=	2.55	m	
(X – (0.5xW))	=	2.59	–	2.55
	=	0.04	m	
(Y – tb)	=	2.321	–	1.00
	=	1.32	m	
H x (Y – tb)	=	370.93	x	1.32
	=	490.15	t.m	

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 2,620.86 x 0.04 – 490.15
= 109.30 – 490.15
= (380.85) t.m

cld–an

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II.1.6 Combined load on Abutment
Normal condition

II.1.6.2 Case – II, Low Water Level

	Item	Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
Super structure	V–sp	23.963		2.100		50.322	
Abutment	V–Abt	28.859		2.587		74.658	
Back fill	V–bf	42.826		2.870		122.911	
			Active earth pressure				
Surcharge load	Hq		1.930		3.250		6.273
Wet soil triangle load	Hwet		11.607		2.167		25.152
Sat.soil rectangular load	Hsat–1						
triangle load	Hsat–2						
Water	Pw in						
	Pw out						
Up life	Pu						
	Total	95.648	13.537			247.891	31.425

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{247.891}{95.648} = 2.592\ m$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{31.425}{13.537} = 2.321\ m$$

V = V/m' x L
= 95.65 x 27.40
= 2,620.86 ton

H = H/m' x L
= 13.54 x 27.40
= 370.93 ton

M = V x (X–(0.5 x W)) – (H x (Y–tb))

0.5 x W	=	0.500	x	5.10
	=	2.55	m	
(X – (0.5xW))	=	2.592	–	2.55
	=	0.04	m	
(Y – tb)	=	2.321	–	1.00
	=	1.32	m	
H x (Y – tb)	=	370.93	x	1.32
	=	490.15	m	

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 2,620.86 x 0.04 – 490.15
= 109.30 – 490.15
= (380.85) t.m

cld–an

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
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Earthquake condition

II.1.6.3 Case – III, High Water Level

Skew angle		=	43.90	degree
sin alpha		=	0.69	degree
Length	L	=	19.00	m
Width of floting	W3	=	5.10	m
Thick of footing	H3	=	1.00	m
Skew length		=	27.40	m
Skew width of footing		=	7.36	m

	Item	V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
Super structure	V–sp	23.963	4.418	2.100	5.555	50.322	24.542
Abutment	V–abt	28.859	5.195	2.587	2.691	74.658	13.980
Back fill	V–bf	42.826	7.709	2.670	4.129	122.911	31.830
				Active earth pressure			
Surcharge load	Pq		1.930		3.250		6.273
triangle load	Pw		11.607		2.167		25.152
rectangular load	Ps1						
triangle load	Ps2						
Water	Pw in						
	Pw out						
Up life	Pu						
	Total	95.648	30.859			247.891	101.777

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{247.891}{95.648} = 2.592\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{101.777}{30.859} = 3.298\ m$$

$V = V/m' \times L = 95.65 \times 27.40 = 2{,}620.86$ ton

$H = H/m' \times L = 30.86 \times 27.40 = 845.57$ ton

$M = V.(X-(0.5.W)) - H.(Y-tb)$

0.5 x W	=	0.50	x	5.10
	=	2.55	m	
(X – (0.5xW))	=	2.59	–	2.55
	=	0.04	m	
(Y – tb)	=	3.298	–	1.00
	=	2.30	m	
H x (Y – tb)	=	845.57	x	2.30
	=	1,943.24	t.m	

$= V \times (X-(0.5 \times W)) - (H \times (Y-tb))$

$= 2{,}620.86 \times 0.04 - 1{,}943.24$

$= 109.30 - 1{,}943.24$

$= (1{,}833.94)$ t.m

cid–aq

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
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Structure	: Br – MF5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

Earthquake condition

II.1.6.4 Case – IV, Low Water Level

	Item	Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
Super structure	V–sp	23.963	4.418	2.100	5.555	50.322	24.542
Abutment	V–Abt	28.859	5.195	2.587	2.691	74.658	13.980
Back fill	V–bf	42.826	7.709	2.670	3.906	122.911	30.111
					Active earth pressure		
Surcharge load	Hq		1.930		3.250		6.273
Wet soil triangle load	Hwet		11.607		2.167		25.152
Sat.soil rectangular load	Hsat–1						
triangle load	Hsat–2						
Water	Pw in						
	Pw out						
Up life	Pu						
	Total	95.648	30.859			247.891	100.058

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{247.891}{95.648} = 2.592\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{100.058}{30.859} = 3.242\ m$$

$V = V/m' \times L = 95.65 \times 27.40 = 2{,}620.86$ ton

$H = H/m' \times L = 30.86 \times 27.40 = 845.57$ ton

$M = V \times (X-(0.5 \times W)) - (H \times (Y-tb))$

0.5 x W	=	0.500	x	5.10
	=	2.55	m	
(X – (0.5xW))	=	2.592	–	2.55
	=	0.04	m	
(Y – tb)	=	3.242	–	1.00
	=	2.24	m	
H x (Y – tb)	=	845.57	x	2.24
	=	1,896.13	m	

$= V \times (X-(0.5 \times W)) - (H \times (Y-tb))$

$= 2{,}620.86 \times 0.04 - 1{,}896.13$

$= 109.30 - 1{,}896.13$

$= (1{,}786.83)$ t.m

cid–aq

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – Mf5 Station : Fw 33 + 65	Japan International Cooperation Agency (JICA)

FOUNDATION

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
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III. FOUNDATION

III.1 Pile for Abutment

III.1.1 Charateristic Value of Concrete Pile

Normal Condition

Beta	=	charateristic value of pile
kh	=	coeficient of horizontal subgrade reaction (kr/cm^3)
EI	=	flexural rigidity of pile
do	=	outer diameter of pile (cm)
Eo	=	modulus of deformation of the ground ontained from table

do	=	40.00	cm	
t	=	7.500	cm	
do^2	=	1,600	cm^2	
di	=	(do–2.t)		
	=	40 –	15	
	=	25	cm	
di^2	=	625	cm^2	
do^2–di^2	=	1,600 –	625	
	=	975	cm	
do^4	=	2,560,000	cm4	
di^4	=	390,625	cm4	
do^4– di^4	=	2,560,000 –	390,625	
	=	2,169,375	cm4	

Modulus elasticity

Modulus elasticity of concrete

Permanent load K – 400

Ec = 343,327 kg/cm2

Modulus elasticity of steel

Es = 1,897,200 kg/cm2

Inertia of pile

Inersia K–400 = @pi/64(do^4–di^4)

= 0.05 x 2,169,375

= 106,469 cm^4

Area of prestress

A prestressed = @pi/4 (do^2 – di^2)

= 0.79 x 975.00

= 765.76 cm^2

$$Beta = \left(\frac{kh.do}{4.E.I}\right)^{0.25}$$

kho = 1/30 x alpa x Eo

Alpha = 0.20 from table 3.5

Eo = 28 x N

= 28.00 x 10.00

= 280 kg/cm3

E.I = 343,327 x 106,469 = 3.66E+10 kg.cm2

4.E.I = 4 x 3.66E+10 = 1.46E+11 kg.cm2

charc–n

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
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III. FOUNDATION

III.1 Pile for Abutment

III.1.1 Charateristic Value of Concrete Pile

kho = 1/30 x Alpa x Eo

= 0.03 x 1 x 280

= 9.33 kg/cm3

$$kh = kho \times \{(Beta\ h)/30\}^{-0.75} \quad (1)\text{--------equition}$$

Beta h = Bh

Beta = B

Bh = @sqrt(do / B)

$$\frac{do}{B} = \frac{40.00}{0.00588039} = 6,802.27$$

---> B find by trial

Bh = 82.48

$$\frac{Bh}{30} = \frac{82.48}{30.00} = 2.75$$

(Bh/30)^–0.7 = 0.47

kh = 9.33 x 0.47

= 4.3715

$$B = \left(\frac{kh \times do}{4.EI}\right)^{0.25} \quad (2)\text{--------equition}$$

$$kh = \frac{Beta^4 \times 4.EI}{do}$$

$$kh = \frac{1.20E-09}{40.00} \times 1.46E+11$$

(1) = (2)

4.3715	=	4.3716 kg/cm3

By trial value of " kh " left side = right side

kh	=	4.3716 kg/cm3
	=	4,371.57 tom/m3
B	=	0.00588 cm–1
B	=	0.588039 m–1
kh x do	=	4.3716 x 40.00
	=	174.86

charc–n

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III. FOUNDATION

III.1 Pile for Abutment

III.1.1 Charateristic Value of Concrete Pile

Allowance Horizontal Force

Normal Condition

$$Han = \frac{kh \times do}{B} \times delta$$

$$= \frac{174.86}{0.01} \times 1.00$$

= 29,736.57 kg

= 29.737 ton

charc–n

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.1.Pile for Abutment

Charateristic Value of Pile

III.1.1.2 Case – II Earthquake Condition

Beta	=	charateristic value of pile			
kh	=	coeficient of horizontal subgrade reaction (kг/cm^3)			
EI	=	flexural rigidity of pile			
do	=	outer diameter of pile (cm)			
Eo	=	modulus of deformation of the ground ontained from table			
do	=	40.00 cm			
t	=	7.500 cm			
do^2	=	1,600 cm^2			
di	=	(do–2.t)			
	=	40 –	15		
	=	25 cm			
di^2	=	625 cm^2			
do^2–di^2	=	1,600 –	625		
	=	975 cm			
do^4	=	2,560,000 cm4			
di^4	=	390,625 cm4			
do^4– di^4	=	2,560,000 –	390,625		
	=	2,169,375 cm4			

Modulus elasticity

Modulus elasticity of concrete

Temporary load K – 400

Ec = 514,991 kg/cm2

Modulus elasticity of steel

Es = 1,897,200 kg/cm2

Inertia of pile

Inersia K–400 = @pi/64(do^4–di^4)

= 0.05 x 2,169,375

= 106,489 cm^4

Area of prestress

A prestressed = @pi/4 (do^2 – di^2)

= 0.79 x 975.00

= 765.76 cm^2

$$Beta = \left(\frac{kh.do}{4.E.I}\right)^{0.25}$$

kho = 1/30 x alpa x Eo

Alpha = 0.20 from table 3.5

Eo = 28 x N

= 28.00 x 10.00

= 280 kg/cm3

E.I = 514,991 x 106,489 = 5.48E+10 kg.cm2

4.E.I = 4 x 5.48E+10 = 2.19E+11 kg.cm2

charc–q

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.1.Pile for Abutment
Charateristic Value of Pile
III.1.1.2 Case – II Earthquake Condition

kho = 1/30 x Alpa x Eo
= 0.03 x 1 x 280
= 9.33 kg/cm3

kh = kho x {(Beta h)/30}^–0.75 (1)--------equition

Beta h = Bh
Beta = B

Bh = @sqrt(do / B)

do / B = 40.00 / 0.00525865 = 7,606.51 ---> B find by trial

Bh = 87.22

(Bh / 30) = 87.22 / 30.00 = 2.91

(Bh/30)^–0.7 = 0.45

kh = 9.33 x 0.45

= 4.1921

B = (kh x do / 4.EI)^0.25 (2)--------equition

kh = Beta^4 x 4.EI / do

kh = 7.65E–10 / 40.00 x 2.19E+11

------ (1) = ------ (2)

4.1921	=	4.1937	kg/cm3

By trial value of " kh " left side = right side

kh = 4.1937 kg/cm3
= 4,193.74 tom/m3
B = 0.00526 cm–1
B = 0.525865 m–1
kh x do = 4.1937 x 40.00
= 167.75

charc–q

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.1.Pile for Abutment
Charateristic Value of Pile
III.1.1.2 Case – II Earthquake Condition

Allowance Horizontal Force

Normal Condition

Han = kh x do / B x delta

= 167.75 / 0.01 x 1.00

= 31,899.73 kg

= 31.900 ton

charc–q

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.1.3 Spring Constante of Prestressed Concrete Pile
III.1.3.1 Case –I Normal condition

Ep = Elasticity of precast prestressed pile concrete
h = axial length of pile above the design ground surface
Beta = charateristic value of pile
k = coeficient of horozontal sub grade reaction (kg/cm^2)
IE = flexural rigidity of pile
K1,K2,K3&K = spring constante
Kv = Axial force (axial spring constante)

di = do–2.t
de = do^2–di^2
df = do^4–di^4

do cm	t cm	di cm	do^2 cm2	di^2 cm2	de cm2	do^4 cm4	di^4 cm4	df cm4
40	7.50	25.00	1,600	625	975	2,560,000	390,625	2,169,375

Ip = @pi/64 x (do^4–di^4)
= 0.0491 x 2,169,375
= 106,489 cm^4

Ap = 1/4.@pi.(do^2–di^2)
= 0.25 x 3.14 x 975
= 765.76 cm2

Ep = 343,327 kg/cm2
Lp = 13.00 m
= 1,300 cm

$$a = 0.041 \times \frac{Lp}{do} - 0.27$$

$$= 0.041 \times \frac{1,300}{40} - 0.27$$

= 0.041 x 32.50 – 0.27
= 1.3325 – 0.27
= 1.0625

Spring constante on axial force = Kv

$$Kv = a \times \frac{Ap}{Lp} \times Ep$$

$$= 1.0625 \times \frac{766}{1,300} \times 343,327$$

= 1.0625 x 202.236
= 214,876 kg/cm
= 21,488 ton/m

E.I = 343,327 x 106,489
= 3.656E+10 kg.cm2

kc – n

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.1.3 Spring Constante of Prestressed Concrete Pile
III.1.3.1 Case –I Normal condition

4.EI = 4 x 3.656E+10
= 1.462E+11 kg.cm2
= 1.462E+11 x 1.00E–07
= 14,624 t.m2

2.EI = 7,312 t.m2
Beta = 0.588039 m–1
Beta^2 = 0.34579 m–2
Beta^3 = 0.2033 m–3

K1 = 4.EI.Beta^3
= 14,624 x 0.2033
= 2,974 ton/m

K2=K3 = 2.EI.Beta^2
= 7,312 x 0.3458
= 2,528 ton/rad

K4 = 2.EI.Beta
= 7,312 x 0.5880
= 4,300 ton.m/rad

kc – n

III.1.3.2 Case – II Earthquake condition

Ep = Elasticity of precast prestressed pile concrete
h = axial length of pile above the design ground surface
Beta = charateristic value of pile
k = coeficient of horozontal sub grade reaction (kg/cm^2)
IE = flexural rigidity of pile
K1,K2,K3&K = spring constante
Kv = Axial force (axial spring constante)

di = do–2.t
de = do^2–di^2
df = do^4–di^4

do cm	t cm	di cm	do^2 cm2	di^2 cm2	de cm2	do^4 cm4	di^4 cm4	df cm4
40	7.50	25.00	1,600	625	975	2,560,000	390,625	2,169,375

Ip = @pi/64 x (do^4–di^4)
= 0.0491 x 2,169,375
= 106,489 cm^4

Ap = 1/4.@pi.(do^2–di^2)
= 0.25 x 3.14 x 975
= 765.76 cm2

Ep = 514,991 kg/cm2
Lp = 13.00 m
= 1,300 cm

$$a = 0.041 \times \frac{Lp}{do} - 0.27$$

$$= 0.041 \times \frac{1,300}{40} - 0.27$$

= 0.041 x 32.50 – 0.27

= 1.3325 – 0.27

= 1.0625

Spring constante on axial force = Kv

$$Kv = a \times \frac{Ap}{Lp} \times Ep$$

$$= 1.0625 \times \frac{766}{1,300} \times 343,327$$

= 1.0625 x 202,236
= 214,878 kg/cm
= 21,488 ton/m

E.I = 514,991 x 106,489
= 5.484E+10 kg.cm2

III.1.3.2 Case – II Earthquake condition

4.EI = 4.00 x 5.484E+10
= 2.194E+11 kg.cm2
= 2.194E+11 x 1.00E–07
= 21,936 t.m2

2.EI = 10,968 t.m2
Beta = 0.525865 m–1
Beta^2 = 0.27653 m–2
Beta^3 = 0.1454 m–3

K1 = 4.EI.Beta^3
= 21,936 x 0.1454
= 3,190 ton/m

K2=K3 = 2.EI.Beta^2
= 10,968 x 0.2765
= 3,033 ton/rad

K4 = 2.EI.Beta
= 10,968 x 0.5259
= 5,768 ton.m/rad

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III.1.4 Coefficient deflection of footing
III.1.4.1 Case – I Normal condition

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)
Axy = tot.(Kv – K1) x sin ø x cos ø)
Ayx = tot.(Kv – K1) x sin ø x cos ø)
Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Aax = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Ayy = tot.(KV x cos ^2 ø + (K1 x sin^2 ø))
Aya = tot.(KV x cos ^2 ø + K1 x sin^2 ø) x Xi + K2 x sin ø)
Aay = tot.(KV x cos ^2 ø + K1 x sin^2 ø) x Xi + K2 x sin ø)
Aaa = tot.(KV x cos ^2 ø + K1 x sin^2 ø) x Xi^2 ^ + (K2 + K3).Xi sin ø + K4)

Abutment		Rows				Total
Nos. of row		(1)	(2)	(3)	(4)	
side		L/s	L/s	R/s	R/s	
sign		(–)	(–)	(+)	(+)	
angle		< 0	< 0	> 0	> 0	
Xi	=	(1.875)	(0.625)	0.625	1.875	
n	=	20.00	20.00	20.00	20.00	
angle degree	=	0.0000	0.0000	0.0000	5.71	
sin ø	=	0.0000	0.00	0.00	0.10	
cos ø	=	1.0000	1.0000	1.0000	0.9950	
sin ø x cosø	=	0.0000	0.00	0.00	0.10	
sin ^2 ø	=	0.0000	0.00	0.00	0.01	
cos^2 ø	=	1.0000	1.0000	1.0000	0.9901	
Xi^2	=	3.5156	0.3906	0.3906	3.5156	
K1	=	2,974.00	2,974.00	2,974.00	2,974.00	
K2	=	2,528.00	2,528.00	2,528.00	2,528.00	
K3	=	2,528.00	2,528.00	2,528.00	2,528.00	
K4	=	4,300.00	4,300.00	4,300.00	4,300.00	
Kv	=	21,488.00	21,488.00	21,488.00	21,488.00	
n.K1	=	59,480	59,480	59,480	59,480	
n.K2	=	50,560	50,560	50,560	50,560	
n.K3	=	50,560	50,560	50,560	50,560	
n.K4	=	86,000	86,000	86,000	86,000	
n.Kv	=	429,760	429,760	429,760	429,760	
n.(K2 + K3)	=	101,120	101,120	101,120	101,120	
Xi.(n.(K2 + K3))	=	(189,600)	(63,200)	63,200	189,600	
Xi.(n.(K2 + K3)).sin ø	=	0	0	0	18,864	
n.(Kv–K1)	=	370,280	370,280	370,280	370,280	
n.(Kv–K1).sin ø.cosø	=	0	0	0	36,658	
n.K1.cos^2 ø	=	59,480	59,480	59,480	58,891	
n.Kv.sin^2 ø	=	0	0	0	4,254	
n.Kv.cos^2 ø	=	429,760	429,760	429,760	425,506	
n.K1.sin^2 ø	=	0	0	0	589	
n.K1.sin ø.cosø	=	0	0	0	5,889	
n.Kv.sin ø.cosø	=	0	0	0	42,546	

coe–disn

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.4 Coefficient deflection of footing
III.1.4.1 Case – I Normal condition

Xi.(n.K1.sin ø.cos ø)	=	0	0	0	11,041	
Xi.(n.Kv.sin ø.cos ø)	=	0	0	0	79,774	
n.K2.cos ø	=	50,560	50,560	50,560	50,309	
n.K2.sin ø	=	0	0	0	5,030	
n.K3.sin ø	=	0	0	0	5,030	
Xi.(n.Kv.cos ^2 ø)	=	(805,800)	(268,600)	268,600	797,823	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	1,104	
Xi^2.(n.Kv.cos ^2 ø)	=	1,510,875	167,875	167,875	1,495,919	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	2,070	
Xi.(n.K2.sin ø)	=	0	0	0	9,432	
Xi.(n.K3.sin ø)	=	0	0	0		
Axx = tot.(K1 x cos ^2 ø + Kv x sin ^2 ø)						
n.K1.cos ^2 ø	=	59,480	59,480	59,480	58,891	
n.Kv.sin ^2 ø	=	0	0	0	4,254	
total		59,480	59,480	59,480	63,145	241,585
Axy = tot.(Kv – K1) x sin ø x cos ø)						
n.(Kv–K1).sin ø.cosø	=	0	0	0	36,658	
A xy	=	0	0	0	36,658	36,658
A yx	=	0	0	0	36,658	36,658
Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))						
Xi.(n.(Kv – K1).sin ø.cc	=	0	0	0	68,733	
– n.K2.cos ø	=	(50,560)	(50,560)	(50,560)	(50,309)	
Axa		(50,560)	(50,560)	(50,560)	18,424	(133,256)
Aax	=	(50,560)	(50,560)	(50,560)	18,424	(133,256)
Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))						
n.Kv.cos ^2 ø	=	429,760	429,760	429,760	425,506	
n.K1.sin ^2 ø	=	0	0	0	589	
Ayy		429,760	429,760	429,760	426,095	1,715,375
Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)						
Xi.(n.Kv.cos ^2 ø)	=	(805,800)	(268,600)	268,600	797,823	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	1,104	
n.K2.sin ø	=	0	0	0	5,030	
Aya	=	(805,800)	(268,600)	268,600	803,958	(1,842)
Aay	=	(805,800)	(268,600)	268,600	803,958	(1,842)
Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi^2 ^ + (K2+K3) Xi sin ø + K4)						
Xi^2.(n.Kv.cos ^2 ø)	=	1,510,875	167,875	167,875	1,495,919	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	2,070	
n.(K2+K3).Xi.sin ø	=	0	0	0	18,864	
n.K4	=	86,000	86,000	86,000	86,000	
Aaa		1,596,875	253,875	253,875	1,602,853	3,707,478

coe–disn

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.4 Coefficient deflection of footing
III.1.4.2 Case – II Earthquake condition

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)
Axy = tot.(Kv – K1) x sin ø x cos ø)
Ayx = tot.(Kv – K1) x sin ø x cos ø)
Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Aax = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Ayy = tot.(KV x cos ^2 ø + (K1 x sin^2 ø))
Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aay = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi^2 ^ + (K2 + K3).Xi sin ø + K4)

Abutment		Rows				Total
Nos. of row		(1)	(2)	(3)	(4)	
side		L/s	L/s	R/s	R/s	
sign		(–)	(–)	(+)	(+)	
angle		< 0	< 0	> 0	> 0	
Xi	=	(1.875)	(0.625)	0.625	1.875	
n	=	20.00	20.00	20.00	20.00	
angle degree	=	0.0000	0.0000	0.0000	5.71	
sin ø	=	0.0000	0.00	0.00	0.10	
cos ø	=	1.0000	1.0000	1.0000	0.9950	
sin ø x cosø	=	0.0000	0.00	0.00	0.10	
sin^2 ø	=	0.0000	0.00	0.00	0.01	
cos^2 ø	=	1.0000	1.0000	1.0000	0.9901	
Xi^2	=	3.5156	0.3906	0.3906	3.5156	
K1	=	3,190.00	3,190.00	3,190.00	3,190.00	
K2	=	3,033.00	3,033.00	3,033.00	3,033.00	
K3	=	3,033.00	3,033.00	3,033.00	3,033.00	
K4	=	5,768.00	5,768.00	5,768.00	5,768.00	
Kv	=	21,488.00	21,488.00	21,488.00	21,488.00	
n.K1	=	63,800	63,800	63,800	63,800	
n.K2	=	60,660	60,660	60,660	60,660	
n.K3	=	60,660	60,660	60,660	60,660	
n.K4	=	115,360	115,360	115,360	115,360	
n.Kv	=	429,760	429,760	429,760	429,760	
n.(K2 + K3)	=	121,320	121,320	121,320	121,320	
Xi.(n.(K2 + K3))	=	(227,475)	(75,825)	75,825	227,475	
Xi.(n.(K2 + K3)).sin ø	=	0	0	0	22,632	
n.(Kv–K1)	=	365,960	365,960	365,960	365,960	
n.(Kv–K1).sin ø.cosø	=	0	0	0	36,230	
n.K1.cos^2 ø	=	63,800	63,800	63,800	63,168	
n.Kv.sin^2 ø	=	0	0	0	4,254	
n.Kv.cos^2 ø	=	429,760	429,760	429,760	425,506	
n.K1.sin^2 ø	=	0	0	0	632	
n.K1.sin ø.cosø	=	0	0	0	6,316	
n.Kv.sin ø.cosø	=	0	0	0	42,546	

coe–disq

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.4 Coefficient deflection of footing
III.1.4.2 Case – II Earthquake condition

Xi.(n.K1.sin ø.cos ø)	=	0	0	0	11,843	
Xi.(n.Kv.sin ø.cos ø)	=	0	0	0	79,774	
n.K2.cos ø	=	60,660	60,660	60,660	60,359	
n.K2.sin ø	=	0	0	0	6,035	
n.K3.sin ø	=	0	0	0	6,035	
Xi.(n.Kv.cos ^2 ø)	=	(805,800)	(268,600)	268,600	797,823	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	1,184	
Xi^2.(n.Kv.cos ^2 ø)	=	1,510,875	167,875	167,875	1,495,919	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	2,220	
Xi.(n.K2.sin ø)	=	0	0	0	11,316	
Xi.(n.K3.sin ø)	=	0	0	0		

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)

n.K1.cos^2 ø	=	63,800	63,800	63,800	63,168	
n.Kv.sin ^2 ø	=	0	0	0	4,254	
total		63,800	63,800	63,800	67,423	258,823

Axy = tot.(Kv – K1) x sin ø x cos ø)

n.(Kv–K1).sin ø.cosø	=	0	0	0	36,230	
A xy	=	0	0	0	36,230	36,230
A yx	=	0	0	0	36,230	36,230

Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))

Xi.(n.(Kv – K1).sin ø.cx	=	0	0	0	67,931	
– n.K2.cos ø	=	(60,660)	(60,660)	(60,660)	(60,359)	
Axa		(60,660)	(60,660)	(60,660)	7,572	(174,408)
Aax	=	(60,660)	(60,660)	(60,660)	7,572	(174,408)

Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))

n.Kv.cos ^2 ø	=	429,760	429,760	429,760	425,506	
n.K1.sin ^2 ø	=	0	0	0	632	
Ayy		429,760	429,760	429,760	426,137	1,715,417

Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)

Xi.(n.Kv.cos ^2 ø)	=	(805,800)	(268,600)	268,600	797,823	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	1,184	
n.K2.sin ø	=	0	0	0	6,035	
Aya	=	(805,800)	(268,600)	268,600	805,043	(757)
Aay	=	(805,800)	(268,600)	268,600	805,043	(757)

Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi^2 ^ + (K2+K3) Xi sin ø + K4)

Xi^2.(n.Kv.cos ^2 ø)	=	1,510,875	167,875	167,875	1,495,919	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	2,220	
n.(K2+K3).Xi.sin ø	=	0	0	0	22,632	
n.K4	=	115,360	115,360	115,360	115,360	
Aaa		1,626,235	283,235	283,235	1,636,132	3,828,837

coe–disq

Project : Medan Flood Control Channel : Percut River Structure : Br. MF – 6 Station : Fw 33 + 65 m	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.1.5 Displacement of head pile
Normal condition
III.1.5.1 Case –I High Water Level

Axx	dx	+	Axy	dy	+	Axz	dz	= H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	= V
Azx	dx	+	Azy	dy	+	Azz	dz	= M

241,585	dx	+	36,658	dy	+	(133,256)	dz	= 370.93 H
36,658	dx	+	1,715,375	dy	+	(1,842)	dz	= 2,620.86 V
(133,256)	dx	+	(1,842)	dy	+	3,707,478	dz	= (380.85) M

det A

2.416E+05	1715375	−1842	=
	−1842	3707478	
36658	36658	−1842	=
	−133256	3707478	
−133256	36658	1715375	=
	−133256	−1842	

+	241585	x(	1715375	x	3707478	−	−1842	x	−1842)	
	241585	x(	6359715074250	−	−3392964	)				= 1.54E+16
−	36658	x(	36658	x	3707478	−	−133256	x	−1842)	
	36658	x(	135808728524	−	−245457552	)				= −4.97E+15
+	−133256	x(	36658	x	−1842	−	−133256	x	1715375)	
	−133256	x(	−87524036	−	2.2858E+11	)				= −3.05E+16
										1.50E+16

$$\frac{1}{\det} = \frac{1}{1.50E+16}$$

Kofactor

a11	1.72E+06	−1.84E+03	+(	1.72E+06	x	3.71E+06	)−(	−1.84E+03	x	−1.84E+03	)=	C11
	−1.84E+03	3.71E+06	+(	6.36E+12			)−(	3.39E+06	)		=	6.36E+12
a12	3.67E+04	−1.84E+03	−(	3.67E+04	x	3.71E+06	)−(	−1.33E+05	x	−1.84E+03	)=	C12
	−1.33E+05	3.71E+06	−(	1.36E+11			)−(	2.45E+08	)		=	−1.36E+11
a13	3.67E+04	1.72E+06	+(	3.67E+04	x	−1.84E+03	)−(	−1.33E+05	x	1.72E+06	)=	C13
	−1.33E+05	−1.84E+03	+(	−6.75E+07			)−(	−2.29E+11	)		=	2.29E+11
a21	3.67E+04	−1.33E+05	−(	3.67E+04	x	3.71E+06	)−(	−1.84E+03	x	−1.33E+05	)=	C21
	−1.84E+03	3.71E+06	−(	1.36E+11			)−(	2.45E+08	)		=	−1.36E+11
a22	2.42E+05	−1.33E+05	+(	2.42E+05	x	3.71E+06	−	−1.33E+05	x	−1.33E+05	)=	C22
	−1.33E+05	3.71E+06	+(	8.96E+11			−	1.78E+10	)		=	8.78E+11
a23	2.42E+05	3.67E+04	+(	2.42E+05	x	−1.84E+03	−	−1.33E+05	x	3.67E+04	)=	C23
	−1.33E+05	−1.84E+03	+(	−4.45E+08			−	−4.88E+09	)		=	−4.44E+09
a31	3.67E+04	−1.33E+05	+(	3.67E+04	x	−1.84E+03	−	1.72E+06	x	−1.33E+05	)=	C31
	1.72E+06	−1.84E+03	+(	−6.75E+07			−	−2.29E+11	)		=	2.29E+11
a32	2.42E+05	−1.33E+05	−(	2.42E+05	x	−1.84E+03	−	3.67E+04	x	−1.33E+05	)=	C32
	3.67E+04	−1.84E+03	−(	−4.45E+08			−	−4.88E+09	)		=	−4.44E+09
a33	2.42E+05	3.67E+04	+(	2.42E+05	x	1.72E+06	−	3.67E+04	x	3.67E+04	)=	C33
	3.67E+04	1.72E+06	+(	4.14E+11			−	1.34E+09	)		=	4.13E+11

C =

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

Adj C = C t =

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

$$A^{-1} = \frac{\text{adj A}}{\det A} = \frac{1}{\det A} \times$$

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

.

3.71E+02
2.62E+03
−3.81E+02

6.36E+12	x	3.71E+02	+	−1.36E+11	x	2.62E+03	+	2.29E+11	x	−3.81E+02
−1.36E+11	x	3.71E+02	+	8.78E+11	x	2.62E+03	+	−4.44E+09	x	−3.81E+02
2.29E+11	x	3.71E+02	+	−4.44E+09	x	2.62E+03	+	4.13E+11	x	−3.81E+02

$$X = A^{-1}.b = \frac{1.00E+00}{1.50E+16} \times$$

2.36E+15	+	−3.56E+14	+	−8.70E+13				
−5.03E+13	+	2.30E+15	+	1.69E+12	=			
8.48E+13	+	−1.16E+13	+	−1.57E+14				

$$X = \frac{1.00E+00}{1.50E+16} \times$$

1.92E+15	=	1.28E−03
2.25E+15		1.50E−03
−8.42E+13		−5.61E−05

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{vmatrix} 0.00127678 \\ 0.00150052 \\ (0.00005609) \end{vmatrix}$$

Control

36,658.00	dx	+	1,715,375.00	dy	+	(1,842.00)	dz	= 2,620.86
36658	x	0.0012767755	=	46.804035 81				
1715375	x	0.0015005189	=	2573.952648				
−1842	x	−0.0000560888	=	0.103315598				
				2620.86	=	2620.86		

def-h1

Project : Medan Flood Control Channel : Percut River Structure : Br. MF – 6 Station : Fw 33 + 65 m	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.1.5 Displacement of head pile
Normal condition
III.1.5.2 Case – II Low Water Level

Axx	dx	+	Axy	dy	+	Axz	dz	= H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	= V
Azx	dx	+	Azy	dy	+	Azz	dz	= M

241,585	dx	+	36,658	dy	+	(133,256)	dz	= 370.93 H
36,658	dx	+	1,715,375	dy	+	(1,842)	dz	= 2,620.86 V
(133,256)	dx	+	(1,842)	dy	+	3,707,478	dz	= (380.85) M

det A

2.42E+05	1.72E+06	−1.84E+03	=
	−1.84E+03	3.71E+06	
3.67E+04	3.67E+04	−1.84E+03	=
	−1.33E+05	3.71E+06	
−1.33E+05	3.67E+04	1.72E+06	=
	−1.33E+05	−1.84E+03	

+	2.42E+05	x(	1.72E+06	x	3.71E+06	−	−1.84E+03	x	−1.84E+03)	
	2.42E+05	x(	6.36E+12	−	−3.39E+06	)				= 1.54E+16
−	3.67E+04	x(	3.67E+04	x	3.71E+06	−	−1.33E+05	x	−1.84E+03)	
	3.67E+04	x(	1.36E+11	−	−2.45E+08	)				= −4.97E+15
+	−1.33E+05	x(	3.67E+04	x	−1.84E+03	−	−1.33E+05	x	1.72E+06)	
	−1.33E+05	x(	−8.75E+07	−	2.29E+11	)				= −3.05E+16
										1.50E+16

$$\frac{1}{\det} = \frac{1.00E+00}{1.50E+16}$$

Kofactor

a11	1.72E+06	−1.84E+03	+(	1.72E+06	x	3.71E+06	)−(	−1.84E+03	x	−1.84E+03	)=	C11
	−1.84E+03	3.71E+06	+(	6.36E+12			)−(	3.39E+06	)		=	6.36E+12
a12	3.67E+04	−1.84E+03	−(	3.67E+04	x	3.71E+06	)−(	−1.33E+05	x	−1.84E+03	)=	C12
	−1.33E+05	3.71E+06	−(	1.36E+11			)−(	2.45E+08	)		=	−1.36E+11
a13	3.67E+04	1.72E+06	+(	3.67E+04	x	−1.84E+03	)−(	−1.33E+05	x	1.72E+06	)=	C13
	−1.33E+05	−1.84E+03	+(	−6.75E+07			)−(	−2.29E+11	)		=	2.29E+11
a21	3.67E+04	−1.33E+05	−(	3.67E+04	x	3.71E+06	)−(	−1.84E+03	x	−1.33E+05	)=	C21
	−1.84E+03	3.71E+06	−(	1.36E+11			)−(	2.45E+08	)		=	−1.36E+11
a22	2.42E+05	−1.33E+05	+(	2.42E+05	x	3.71E+06	−	−1.33E+05	x	−1.33E+05	)=	C22
	−1.33E+05	3.71E+06	+(	8.96E+11			−	1.78E+10	)		=	8.78E+11
a23	2.42E+05	3.67E+04	+(	2.42E+05	x	−1.84E+03	−	−1.33E+05	x	3.67E+04	)=	C23
	−1.33E+05	−1.84E+03	+(	−4.45E+08			−	−4.88E+09	)		=	−4.44E+09
a31	3.67E+04	−1.33E+05	+(	3.67E+04	x	−1.84E+03	−	1.72E+06	x	−1.33E+05	)=	C31
	1.72E+06	−1.84E+03	+(	−6.75E+07			−	−2.29E+11	)		=	2.29E+11
a32	2.42E+05	−1.33E+05	−(	2.42E+05	x	−1.84E+03	−	3.67E+04	x	−1.33E+05	)=	C32
	3.67E+04	−1.84E+03	−(	−4.45E+08			−	−4.88E+09	)		=	−4.44E+09
a33	2.42E+05	3.67E+04	+(	2.42E+05	x	1.72E+06	−	3.67E+04	x	3.67E+04	)=	C33
	3.67E+04	1.72E+06	+(	4.14E+11			−	1.34E+09	)		=	4.13E+11

C =

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

Adj C = C t =

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

$$A^{-1} = \frac{\text{adj A}}{\det A} = \frac{1}{\det A} \times$$

6.36E+12	−1.36E+11	2.29E+11
−1.36E+11	8.78E+11	−4.44E+09
2.29E+11	−4.44E+09	4.13E+11

.

3.71E+02
2.62E+03
−3.81E+02

6.36E+12	x	3.71E+02	+	−1.36E+11	x	2.62E+03	+	2.29E+11	x	−3.81E+02
−1.36E+11	x	3.71E+02	+	8.78E+11	x	2.62E+03	+	−4.44E+09	x	−3.81E+02
2.29E+11	x	3.71E+02	+	−4.44E+09	x	2.62E+03	+	4.13E+11	x	−3.81E+02

$$X = A^{-1}.b = \frac{1.00E+00}{1.50E+16} \times$$

2.36E+15	+	−3.56E+14	+	−8.70E+13				
−5.03E+13	+	2.30E+15	+	1.69E+12	=			
8.48E+13	+	−1.16E+13	+	−1.57E+14				

$$X = \frac{1.00E+00}{1.50E+16} \times$$

1.92E+15	=	1.28E−03
2.25E+15		1.50E−03
−8.42E+13		−5.61E−05

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{vmatrix} 0.00127678 \\ 0.00150052 \\ (0.00005609) \end{vmatrix}$$

Control

36,658.00	dx	+	1,715,375.00	dy	+	(1,842.00)	dz	= 2,620.86
36658	x	0.0012767755	=	46.804035812				
1715375	x	0.0015005189	=	2573.9526486				
−1842	x	−0.0000560888	=	0.1033155983				
				2620.86	=	2620.86		

def-h2

Project	: Medan Flood Control
Channel	: Percut River
Structure	: Br. MF – 5
Station	: Fw 33 + 65 m

Japan International Cooperation Agency (JICA)

Calculation sheet	
Date	
Nos of sheet	
Prepared by	

III.1.5 Displacement of head pile
Earthquake condition
III.1.5.3 Case – III High Water Level

Axx	dx	+	Axy	dy	+	Axz	dz	=	H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	=	V
Axx	dx	+	Asy	dy	+	Azz	dz	=	M

258,823	dx	+	36,230	dy	+	(174,408)	dz	=	845.57 H
36,230	dx	+	1,715,417	dy	+	(757)	dz	=	2,620.86 V
(174,408)	dx	+	(757)	dy	+	3,826,837	dz	=	(1,833.94) M

det A

2.59E+05	1.72E+06	−7.57E+02	=
	−7.57E+02	3.83E+06	
3.62E+04	3.62E+04	−7.57E+02	=
	−1.74E+05	3.83E+06	
−1.74E+05	3.62E+04	1.72E+06	=
	−1.74E+05	−7.57E+02	

+	2.59E+05	x(	1.72E+06	x	3.83E+06	−	−7.57E+02	x	−7.57E+02	)		
	2.59E+05	x(	6.57E+12	−	−5.73E+05	)					=	1.70E+18
−	3.62E+04	x(	3.62E+04	x	3.83E+06	−	−1.74E+05	x	−7.57E+02	)		
	3.62E+04	x(	1.39E+11	−	−1.32E+06	)					=	−5.02E+15
+	−1.74E+05	x(	3.62E+04	x	−7.57E+02	−	−1.74E+05	x	1.72E+06	)		
	−1.74E+05	x(	−2.74E+07	−	2.99E+11	)					=	−5.22E+16
												1.64E+18

1 / det	=	1.00E+00 / 1.64E+18	

Kofactor

a11	1.72E+06	−7.57E+02	+(	1.72E+06	x	3.83E+06	)−(	−7.57E+02	x	−7.57E+02	)=	C11	
	−7.57E+02	3.83E+06	+(	6.57E+12			)−(	5.73E+05	)		=	6.57E+12	
a12	3.62E+04	−7.57E+02	−(	3.62E+04	x	3.83E+06	)−(	−1.74E+05	x	−7.57E+02	)=	C12	
	−1.74E+05	3.83E+06	−(	1.39E+11			)−(	1.32E+06	)		=	−1.39E+11	
a13	3.62E+04	1.72E+06	+(	3.62E+04	x	−7.57E+02	)−(	−1.74E+05	x	1.72E+06	)=	C13	
	−1.74E+05	−7.57E+02	+(	−2.74E+07			)−(	−2.99E+11	)		=	2.99E+11	
a21	3.62E+04	−1.74E+05	−(	3.62E+04	x	3.83E+06	)−(	−7.57E+02	x	−1.74E+05	)=	C21	
	−7.57E+02	3.83E+06	−(	1.39E+11			)−(	1.32E+06	)		=	−1.39E+11	
a22	2.59E+05	−1.74E+05	+(	2.59E+05	x	3.83E+06	−	−1.74E+05	x	−1.74E+05	)=	C22	
	−1.74E+05	3.83E+06	+(	9.91E+11			−	3.04E+10	)		=	9.61E+11	
a23	2.59E+05	3.62E+04	+(	2.59E+05	x	−7.57E+02	−	−1.74E+05	x	3.62E+04	)=	C23	
	−1.74E+05	−7.57E+02	+(	−1.96E+08			−	−6.32E+09	)		=	−6.12E+09	
a31	3.62E+04	−1.74E+05	+(	3.62E+04	x	−7.57E+02	−	1.72E+06	x	−1.74E+05	)=	C31	
	1.72E+06	−7.57E+02	+(	−2.74E+07			−	−2.99E+11	)		=	2.99E+11	
a32	2.59E+05	−1.74E+05	−(	2.59E+05	x	−7.57E+02	−	3.62E+04	x	−1.74E+05	)=	C32	
	3.62E+04	−7.57E+02	−(	−1.96E+08			−	−6.32E+09	)		=	−6.12E+09	
a33	2.59E+05	3.62E+04	+(	2.59E+05	x	1.72E+06	−	3.62E+04	x	3.62E+04	)=	C33	
	3.62E+04	1.72E+06	+(	4.44E+11			−	1.31E+09	)		=	4.43E+11	

C =	6.57E+12	−1.39E+11	2.99E+11	Adj C = C t =	6.57E+12 −1.39E+11 2.99E+11
	−1.39E+11	9.61E+11	−6.12E+09		−1.39E+11 9.61E+11 −6.12E+09
	2.99E+11	−6.12E+09	4.43E+11		2.99E+11 −6.12E+09 4.43E+11

A^−1	=	adj A / det A	=	1 / det A	x	6.57E+12	−1.39E+11	2.99E+11	.	8.46E+02			
						−1.39E+11	9.61E+11	−6.12E+09		2.62E+03			
						2.99E+11	−6.12E+09	4.43E+11		−1.83E+03			

6.57E+12	x	8.46E+02	+	−1.39E+11	x	2.62E+03	+	2.99E+11	x	−1.83E+03			
−1.39E+11	x	8.46E+02	+	9.61E+11	x	2.62E+03	+	−6.12E+09	x	−1.83E+03			
2.99E+11	x	8.46E+02	+	−6.12E+09	x	2.62E+03	+	4.43E+11	x	−1.83E+03			

X =	A^−1.b	=	1.00E+00 / 1.64E+18	x	5.55E+15	+	−3.63E+14	+	−5.49E+14				
					−1.17E+14	+	2.52E+15	+	1.12E+13	=			
					2.53E+14	+	−1.60E+13	+	−8.12E+14				

X =	1.00E+00 / 1.64E+18	x	4.64E+15	2.41E+15	−5.75E+14	= 2.83E−03 1.47E−03 −3.50E−04

X =	dx	=	0.00282566
	dy	=	0.00146799
	dz	=	(0.00034998)

Control

36,230.00	dx	+	1,715,417.00	dy	+	(757.00) dz	= 2,620.86
36230	x	0.0028256589	=	102.373621			
1715417	x	0.0014579934	=	2518.22144			
−757	x	−0.0003499787	=	0.26493384			
				2620.86	=	2620.86	

def−h3

Project	: Medan Flood Control
Channel	: Percut River
Structure	: Br. MF – 5
Station	: Fw 33 + 65 m

Japan International Cooperation Agency (JICA)

Calculation sheet	
Date	
Nos of sheet	
Prepared by	

III.1.5 Displacement of head pile
Earthquake condition
III.1.5.4 Case – IV Low Water Level

Axx	dx	+	Axy	dy	+	Axz	dz	=	H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	=	V
Axx	dx	+	Asy	dy	+	Azz	dz	=	M

258,823	dx	+	36,230	dy	+	(174,408)	dz	=	845.57 H
36,230	dx	+	1,715,417	dy	+	(757)	dz	=	2,620.86 V
(174,408)	dx	+	(757)	dy	+	3,826,837	dz	=	(1,788.83) M

1/1

det A

2.59E+05	1.72E+06	−7.57E+02	=
	−7.57E+02	3.83E+06	
3.62E+04	3.62E+04	−7.57E+02	=
	−1.74E+05	3.83E+06	
−1.74E+05	3.62E+04	1.72E+06	=
	−1.74E+05	−7.57E+02	

+	2.59E+05	x(	1.72E+06	x	3.83E+06	−	−7.57E+02	x	−7.57E+02	)		
	2.59E+05	x(	6.57E+12	−	−5.73E+05	)					=	1.70E+18
−	3.62E+04	x(	3.62E+04	x	3.83E+06	−	−1.74E+05	x	−7.57E+02	)		
	3.62E+04	x(	1.39E+11	−	−1.32E+06	)					=	−5.02E+15
+	−1.74E+05	x(	3.62E+04	x	−7.57E+02	−	−1.74E+05	x	1.72E+06	)		
	−1.74E+05	x(	−2.74E+07	−	2.99E+11	)					=	−5.22E+16
												1.64E+18

1 / det	=	1.00E+00 / 1.64E+18	

Kofactor

a11	1.72E+06	−7.57E+02	+(	1.72E+06	x	3.83E+06	)−(	−7.57E+02	x	−7.57E+02	)=	C11	
	−7.57E+02	3.83E+06	+(	6.57E+12			)−(	5.73E+05	)		=	6.57E+12	
a12	3.62E+04	−7.57E+02	−(	3.62E+04	x	3.83E+06	)−(	−1.74E+05	x	−7.57E+02	)=	C12	
	−1.74E+05	3.83E+06	−(	1.39E+11			)−(	1.32E+06	)		=	−1.39E+11	
a13	3.62E+04	1.72E+06	+(	3.62E+04	x	−7.57E+02	)−(	−1.74E+05	x	1.72E+06	)=	C13	
	−1.74E+05	−7.57E+02	+(	−2.74E+07			)−(	−2.99E+11	)		=	2.99E+11	
a21	3.62E+04	−1.74E+05	−(	3.62E+04	x	3.83E+06	)−(	−7.57E+02	x	−1.74E+05	)=	C21	
	−7.57E+02	3.83E+06	−(	1.39E+11			)−(	1.32E+06	)		=	−1.39E+11	
a22	2.59E+05	−1.74E+05	+(	2.59E+05	x	3.83E+06	−	−1.74E+05	x	−1.74E+05	)=	C22	
	−1.74E+05	3.83E+06	+(	9.91E+11			−	3.04E+10	)		=	9.61E+11	
a23	2.59E+05	3.62E+04	+(	2.59E+05	x	−7.57E+02	−	−1.74E+05	x	3.62E+04	)=	C23	
	−1.74E+05	−7.57E+02	+(	−1.96E+08			−	−6.32E+09	)		=	−6.12E+09	
a31	3.62E+04	−1.74E+05	+(	3.62E+04	x	−7.57E+02	−	1.72E+06	x	−1.74E+05	)=	C31	
	1.72E+06	−7.57E+02	+(	−2.74E+07			−	−2.99E+11	)		=	2.99E+11	
a32	2.59E+05	−1.74E+05	−(	2.59E+05	x	−7.57E+02	−	3.62E+04	x	−1.74E+05	)=	C32	
	3.62E+04	−7.57E+02	−(	−1.96E+08			−	−6.32E+09	)		=	−6.12E+09	
a33	2.59E+05	3.62E+04	+(	2.59E+05	x	1.72E+06	−	3.62E+04	x	3.62E+04	)=	C33	
	3.62E+04	1.72E+06	+(	4.44E+11			−	1.31E+09	)		=	4.43E+11	

C =	6.57E+12	−1.39E+11	2.99E+11	Adj C = C t =	6.57E+12 −1.39E+11 2.99E+11
	−1.39E+11	9.61E+11	−6.12E+09		−1.39E+11 9.61E+11 −6.12E+09
	2.99E+11	−6.12E+09	4.43E+11		2.99E+11 −6.12E+09 4.43E+11

A^−1	=	adj A / det A	=	1 / det A	x	6.57E+12	−1.39E+11	2.99E+11	.	8.46E+02			
						−1.39E+11	9.61E+11	−6.12E+09		2.62E+03			
						2.99E+11	−6.12E+09	4.43E+11		−1.79E+03			

6.57E+12	x	8.46E+02	+	−1.39E+11	x	2.62E+03	+	2.99E+11	x	−1.79E+03			
−1.39E+11	x	8.46E+02	+	9.61E+11	x	2.62E+03	+	−6.12E+09	x	−1.79E+03			
2.99E+11	x	8.46E+02	+	−6.12E+09	x	2.62E+03	+	4.43E+11	x	−1.79E+03			

X =	A^−1.b	=	1.00E+00 / 1.64E+18	x	5.55E+15	+	−3.63E+14	+	−5.35E+14				
					−1.17E+14	+	2.52E+15	+	1.09E+13	=			
					2.53E+14	+	−1.60E+13	+	−7.91E+14				

X =	1.00E+00 / 1.64E+18	x	4.66E+15	2.41E+15	−5.54E+14	= 2.83E−03 1.47E−03 −3.37E−04

X =	dx	=	0.00283424
	dy	=	0.00146782
	dz	=	(0.00033728)

Control

36,230.00	dx	+	1,715,417.00	dy	+	(757.00) dz	= 2,620.86
36230	x	0.0028342378	=	102.6844362			
1715417	x	0.0014678182	=	2517.920239			
−757	x	−0.0003372839	=	0.255323918			
				2620.86	=	2620.86	

def−h4

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.6 Force at each pile head
Normal condition
III.1.6.1 Case I High Water Level

dxi = (dxi.cos ø) – (dy + alpa.Xi).sin ø)
dyi = (dxi.sin ø) + (dy + alpa.Xi)cos ø)

		Side sign degree	Row of pile (1) L/s (–) < 0	(2) L/s (–) < 0	(3) R/s (+) > 0	(4) R/s (+) > 0	total per row
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			20.00	20.00	20.00	20.00	
ø	degree		0.00	0.00	0.00	5.71	
cos ø	degree		1.000	1.000	1.000	0.995	
sin ø	degree		0.000	0.000	0.000	0.099	
K1	t.m		2,974	2,974	2,974	2,974	
K2	t.m/rad		2,528	2,528	2,528	2,528	
K3	t.m/rad		2,528	2,528	2,528	2,528	
K4	t.m		4,300	4,300	4,300	4,300	
Kv	t.m		21,488	21,488	21,488	21,488	
dx	m		0.00127678	0.00127678	0.00127678	0.00127678	
dy	m		0.00150052	0.00150052	0.00150052	0.00150052	
alpa	rad		(0.00005609)	(0.00005609)	(0.00005609)	(0.00005609)	
dxi = dx cos ø – (dy + alpa.Xi).sin ø							
dx.cos ø	=		0.00128	0.00128	0.00128	0.00127	
dy	=		0.00150	0.00150	0.00150	0.00150	
alpa	=		(0.00006)	(0.00006)	(0.00006)	(0.00006)	
Alpa x Xi	=		0.00011	0.00004	(0.00004)	(0.00011)	
dy + Alpa x Xi	=		0.00161	0.00154	0.00147	0.00140	
(dy + alpa.Xi).sin ø	=		0.00000	0.00000	0.00000	0.00014	
dxi	=		0.00128	0.00128	0.00128	0.00113	
dyi = dx sin ø + (dy + alpa.Xi).cos ø							
dx.sin ø	=		0.0000000	0.0000000	0.0000000	0.0001270	
dy	=		0.0015005	0.0015005	0.0015005	0.0015005	
alpa	=		(0.0000561)	(0.0000561)	(0.0000561)	(0.0000561)	
Alpa x Xi	=		0.0001052	0.0000351	(0.0000351)	(0.0001052)	
dy + Alpa x Xi	=		0.0016057	0.0015356	0.0014655	0.0013954	
(dy + alpa.Xi).cos ø	=		0.0016057	0.0015356	0.0014655	0.0013884	
dyi	=		0.0016057	0.0015356	0.0014655	0.0015155	
P ni=Kv.dyi			34.50	33.00	31.49	32.56	
K1.dxi	=		3.80	3.80	3.80	3.37	
K2.alpa	=		(0.14)	(0.14)	(0.14)	(0.14)	
P hi=K1.dxi–K2.alpa	=		3.94	3.94	3.94	3.51	
K3.dxi	=		3.23	3.23	3.23	2.86	
K4.alpa	=		(0.24)	(0.24)	(0.24)	(0.24)	
M ti=–K3.dxi+K4.alpa	=		(3.47)	(3.47)	(3.47)	(3.10)	(13.51)
Mti x n	=		(69.38)	(69.38)	(69.38)	(62.04)	(270.17)
Vi = Pni.cos ø – Phi.sin ø							
Pni.cos	=		34.50	33.00	31.49	32.40	
Phi.sin ø	=		0.00	0.00	0.00	0.35	
Vi	=		34.50	33.00	31.49	32.05	
Vi.n	=		690.06	659.93	629.80	641.07	2,620.86
Hi= Pni.sin ø + Phi.cos ø							
Pni.sin ø	=		0.0	0.0	0.0	3.2	
Phi.cos ø	=		3.9	3.9	3.9	3.5	
Hi	=		3.94	3.94	3.94	6.73	
Hi.n	=		78.78	78.78	78.78	134.59	370.93
Vi.n.X	=		(1,293.86)	(412.46)	393.62	1,202.01	
Mti.n	=		(69.38)	(69.38)	(69.38)	(62.04)	
Mt=Mti.n + Vi.n.X	=		(1,363.24)	(481.83)	324.25	1,139.97	(380.86)

Total forces at footing of Abutment

Ho	=	370.93	ton
Vo	=	2,620.86	ton
Mo	=	(380.86)	t.m

Total forces at pile head

Hi.n = Ho	370.93	ton
Vi.n = Vo	2,620.86	ton
Mt = Mo	(380.86)	t.m

mnh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.6 Force at each pile head
Normal condition
III.1.6.2 Case II Low Water Level

dxi = (dxi.cos ø) – (dy + alpa.Xi).sin ø)
dyi = (dxi.sin ø) + (dy + alpa.Xi)cos ø)

		Side sign degree	Row of pile (1) L/s (–) < 0	(2) L/s (–) < 0	(3) R/s (+) > 0	(4) R/s (+) > 0	total per row
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			20.00	20.00	20.00	20.00	
ø	degree		0.00	0.00	0.00	5.71	
cos ø	degree		1.000	1.000	1.000	0.995	
sin ø	degree		0.000	0.000	0.000	0.099	
K1	t.m		2,974	2,974	2,974	2,974	
K2	t.m/rad		2,528	2,528	2,528	2,528	
K3	t.m/rad		2,528	2,528	2,528	2,528	
K4	t.m		4,300	4,300	4,300	4,300	
Kv	t.m		21,488	21,488	21,488	21,488	
dx	m		0.00127678	0.00127678	0.00127678	0.00127678	
dy	m		0.00150052	0.00150052	0.00150052	0.00150052	
alpa	rad		(0.00005609)	(0.00005609)	(0.00005609)	(0.00005609)	
dxi = dx cos ø – (dy + alpa.Xi).sin ø							
dx.cos ø	=		0.00128	0.00128	0.00128	0.00127	
dy	=		0.00150	0.00150	0.00150	0.00150	
alpa	=		(0.00006)	(0.00006)	(0.00006)	(0.00006)	
Alpa x Xi	=		0.00011	0.00004	(0.00004)	(0.00011)	
dy + Alpa x Xi	=		0.00161	0.00154	0.00147	0.00140	
(dy + alpa.Xi).sin ø	=		0.00000	0.00000	0.00000	0.00014	
dxi	=		0.00128	0.00128	0.00128	0.00113	
dyi = dx sin ø + (dy + alpa.Xi).cos ø							
dx.sin ø	=		0.0000000	0.0000000	0.0000000	0.0001270	
dy	=		0.0015005	0.0015005	0.0015005	0.0015005	
alpa	=		(0.0000561)	(0.0000561)	(0.0000561)	(0.0000561)	
Alpa x Xi	=		0.0001052	0.0000351	(0.0000351)	(0.0001052)	
dy + Alpa x Xi	=		0.0016057	0.0015356	0.0014655	0.0013954	
(dy + alpa.Xi).cos ø	=		0.0016057	0.0015356	0.0014655	0.0013884	
dyi	=		0.0016057	0.0015356	0.0014655	0.0015155	
P ni=Kv.dyi			34.50	33.00	31.49	32.56	
K1.dxi	=		3.80	3.80	3.80	3.37	
K2.alpa	=		(0.14)	(0.14)	(0.14)	(0.14)	
P hi=K1.dxi–K2.alpa	=		3.94	3.94	3.94	3.51	
K3.dxi	=		3.23	3.23	3.23	2.86	
K4.alpa	=		(0.24)	(0.24)	(0.24)	(0.24)	
M ti=–K3.dxi+K4.alpa	=		(3.47)	(3.47)	(3.47)	(3.10)	(13.51)
Mti x n	=		(69.38)	(69.38)	(69.38)	(62.04)	(270.17)
Vi = Pni.cos ø – Phi.sin ø							
Pni.cos	=		34.50	33.00	31.49	32.40	
Phi.sin ø	=		0.00	0.00	0.00	0.35	
Vi	=		34.50	33.00	31.49	32.05	
Vi.n	=		690.06	659.93	629.80	641.07	2,620.86
Hi= Pni.sin ø + Phi.cos ø							
Pni.sin ø	=		0.0	0.0	0.0	3.2	
Phi.cos ø	=		3.9	3.9	3.9	3.5	
Hi	=		3.94	3.94	3.94	6.73	
Hi.n	=		78.78	78.78	78.78	134.59	370.93
Vi.n.X	=		(1,293.86)	(412.46)	393.62	1,202.01	
Mti.n	=		(69.38)	(69.38)	(69.38)	(62.04)	
Mt=Mti.n + Vi.n.X	=		(1,363.24)	(481.83)	324.25	1,139.97	(380.86)

Total forces at footing of Abutment

Ho	=	370.93	ton
Vo	=	2,620.86	ton
Mo	=	(380.86)	t.m

Total forces at pile head

Hi.n = Ho	370.93	ton
Vi.n = Vo	2,620.86	ton
Mt = Mo	(380.86)	t.m

mnh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.6 Force at each pile head
Earthquake condition
III.1.6.3 Case – III High Water Level

dxi = (dxi.cos ø) – (dy + alpa.Xi).sin ø)
dyi = (dxi.sin ø) + (dy + alpa.Xi)cos ø)

		Side sign	Row of pile (1) L/s (–)	(2) L/s (–)	(3) R/s (+)	(4) R/s (+)	total per row
		degree	< 0	< 0	> 0	> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			20.00	20.00	20.00	20.00	
ø	degree		0.00	0.00	0.00	5.71	
cos ø	degree		1.000	1.000	1.000	0.995	
sin ø	degree		0.000	0.000	0.000	0.099	
K1	t.m		3,190	3,190	3,190	3,190	
K2	t.m/rad		3,033	3,033	3,033	3,033	
K3	t.m/rad		3,033	3,033	3,033	3,033	
K4	t.m		5,768	5,768	5,768	5,768	
Kv	t.m		21,488	21,488	21,488	21,488	
dx	m		0.00282566	0.00282566	0.00282566	0.00282566	
dy	m		0.00146799	0.00146799	0.00146799	0.00146799	
alpa	rad		(0.00034998)	(0.00034998)	(0.00034998)	(0.00034998)	
dxi = dx cos ø – (dy + alpa.Xi).sin ø							
dx.cos ø	=		0.00283	0.00283	0.00283	0.00281	
dy	=		0.00147	0.00147	0.00147	0.00147	
alpa	=		(0.00035)	(0.00035)	(0.00035)	(0.00035)	
Alpa x Xi	=		0.00066	0.00022	(0.00022)	(0.00066)	
dy + Alpa x Xi	=		0.00212	0.00169	0.00125	0.00081	
(dy + alpa.Xi).sin ø	=		0.00000	0.00000	0.00000	0.00008	
dxi	=		0.00283	0.00283	0.00283	0.00273	
dyi = dx sin ø + (dy + alpa.Xi).cos ø							
dx.sin ø	=		0.0000000	0.0000000	0.0000000	0.0002811	
dy	=		0.0014680	0.0014680	0.0014680	0.0014680	
alpa	=		(0.0003500)	(0.0003500)	(0.0003500)	(0.0003500)	
Alpa x Xi	=		0.0006562	0.0002187	(0.0002187)	(0.0006562)	
dy + Alpa x Xi	=		0.0021242	0.0016867	0.0012493	0.0008118	
(dy + alpa.Xi).cos ø	=		0.0021242	0.0016867	0.0012493	0.0008077	
dyi	=		0.0021242	0.0016867	0.0012493	0.0010889	
P ni=Kv.dyi			45.64	36.24	26.84	23.40	
K1.dxi	=		9.01	9.01	9.01	8.71	
K2.alpa	=		(1.06)	(1.06)	(1.06)	(1.06)	
P hi=K1.dxi–K2.alpa	=		10.08	10.08	10.08	9.77	
K3.dxi	=		8.57	8.57	8.57	8.28	
K4.alpa	=		(2.02)	(2.02)	(2.02)	(2.02)	
M ti=–K3.dxi+K4.alpa	=		(10.59)	(10.59)	(10.59)	(10.30)	(42.07)
Mti x n	=		(211.78)	(211.78)	(211.78)	(206.03)	(841.36)
Vi = Pni.cos ø – Phi.sin ø							
Pni.cos	=		45.64	36.24	26.84	23.28	
Phi.sin ø	=		0.00	0.00	0.00	0.97	
Vi	=		45.64	36.24	26.84	22.31	
Vi.n	=		912.90	724.89	536.88	446.19	2,620.85
Hi= Pni.sin ø + Phi.cos ø							
Pni.sin ø	=		0.0	0.0	0.0	2.3	
Phi.cos ø	=		10.1	10.1	10.1	9.7	
Hi	=		10.08	10.08	10.08	12.05	
Hi.n	=		201.51	201.51	201.51	241.05	845.57
Vi.n.X	=		(1,711.68)	(453.06)	335.55	836.61	
Mti.n	=		(211.78)	(211.78)	(211.78)	(206.03)	
Mt=Mti.n + Vi.n.X	=		(1,923.46)	(664.83)	123.77	630.58	(1,833.94)

Total forces at footing of Abutment

Ho	=	845.57	ton
Vo	=	2,620.85	ton
Mo	=	(1,833.94)	t.m

Total forces at pile head

Hi.n = Ho	845.57	ton
Vi.n = Vo	2,620.85	ton
Mt = Mo	(1,833.94)	t.m

mnh–3

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.6 Force at each pile head
Earthquake condition
III.1.6.4 Case IV Low Water Level

dxi = (dxi.cos ø) – (dy + alpa.Xi).sin ø)
dyi = (dxi.sin ø) + (dy + alpa.Xi)cos ø)

		Side sign	Row of pile (1) L/s (–)	(2) L/s (–)	(3) R/s (+)	(4) R/s (+)	total per row
		degree	< 0	< 0	> 0	> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			20.00	20.00	20.00	20.00	
ø	degree		0.00	0.00	0.00	5.71	
cos ø	degree		1.000	1.000	1.000	0.995	
sin ø	degree		0.000	0.000	0.000	0.099	
K1	t.m		3,190	3,190	3,190	3,190	
K2	t.m/rad		3,033	3,033	3,033	3,033	
K3	t.m/rad		3,033	3,033	3,033	3,033	
K4	t.m		5,768	5,768	5,768	5,768	
Kv	t.m		21,488	21,488	21,488	21,488	
dx	m		0.00283424	0.00283424	0.00283424	0.00283424	
dy	m		0.00146782	0.00146782	0.00146782	0.00146782	
alpa	rad		(0.00033726)	(0.00033726)	(0.00033726)	(0.00033726)	
dxi = dx cos ø – (dy + alpa.Xi).sin ø							
dx.cos ø	=		0.00283	0.00283	0.00283	0.00282	
dy	=		0.00147	0.00147	0.00147	0.00147	
alpa	=		(0.00034)	(0.00034)	(0.00034)	(0.00034)	
Alpa x Xi	=		0.00063	0.00021	(0.00021)	(0.00063)	
dy + Alpa x Xi	=		0.00210	0.00168	0.00126	0.00084	
(dy + alpa.Xi).sin ø	=		0.00000	0.00000	0.00000	0.00008	
dxi	=		0.00283	0.00283	0.00283	0.00274	
dyi = dx sin ø + (dy + alpa.Xi).cos ø							
dx.sin ø	=		0.0000000	0.0000000	0.0000000	0.0002820	
dy	=		0.0014678	0.0014678	0.0014678	0.0014678	
alpa	=		(0.0003373)	(0.0003373)	(0.0003373)	(0.0003373)	
Alpa x Xi	=		0.0006324	0.0002108	(0.0002108)	(0.0006324)	
dy + Alpa x Xi	=		0.0021002	0.0016786	0.0012570	0.0008354	
(dy + alpa.Xi).cos ø	=		0.0021002	0.0016786	0.0012570	0.0008313	
dyi	=		0.0021002	0.0016786	0.0012570	0.0011133	
P ni=Kv.dyi			45.13	36.07	27.01	23.92	
K1.dxi	=		9.04	9.04	9.04	8.73	
K2.alpa	=		(1.02)	(1.02)	(1.02)	(1.02)	
P hi=K1.dxi–K2.alpa	=		10.06	10.06	10.06	9.75	
K3.dxi	=		8.60	8.60	8.60	8.30	
K4.alpa	=		(1.95)	(1.95)	(1.95)	(1.95)	
M ti=–K3.dxi+K4.alpa	=		(10.54)	(10.54)	(10.54)	(10.25)	(41.87)
Mti x n	=		(210.83)	(210.83)	(210.83)	(204.94)	(837.44)
Vi = Pni.cos ø – Phi.sin ø							
Pni.cos	=		45.13	36.07	27.01	23.80	
Phi.sin ø	=		0.00	0.00	0.00	0.97	
Vi	=		45.13	36.07	27.01	22.83	
Vi.n	=		902.59	721.40	540.22	456.65	2,620.86
Hi= Pni.sin ø + Phi.cos ø							
Pni.sin ø	=		0.0	0.0	0.0	2.4	
Phi.cos ø	=		10.1	10.1	10.1	9.7	
Hi	=		10.06	10.06	10.06	12.09	
Hi.n	=		201.28	201.28	201.28	241.72	845.57
Vi.n.X	=		(1,692.36)	(450.66)	337.64	856.22	
Mti.n	=		(210.83)	(210.83)	(210.83)	(204.94)	
Mt=Mti.n + Vi.n.X	=		(1,903.19)	(661.71)	126.80	651.28	(1,786.82)

Total forces at footing of Abutment

Ho	=	845.57	ton
Vo	=	2,620.86	ton
Mo	=	(1,786.82)	t.m

Total forces at pile head

Hi.n = Ho	845.57	ton
Vi.n = Vo	2,620.86	ton
Mt = Mo	(1,786.82)	t.m

mnh–4

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F5 Station : FW 33 + 65	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.1.7 Control stresses on pile
Normal Condition
III.1.7.1 Case – I High Water Level

Depth embedded of pile = 14.00 m
Axial load Vi = 34.370 ton
34,370 kg

Moment Mi = (2.590) t.m
= (259,000) kg.cm

diameter do = 40.00 cm
outer radius ro = 20.00 cm

M' = Mx + Vi x ro
= (259,000) + 34,370 x 20.00
= (259,000) + 687,400
= 428,400 kg.cm

excentrisitas $e = \frac{Mx}{Vi}$

$= \frac{(259,000)\ kg.cm}{34,370\ kg}$

= (7.54) cm

concrete covering s' = 2.50 cm

t = 1.03 cm

Inner diameter di = 40.00 – 2.06
= 37.94
inner radius ri = 18.97 cm

ro^2 = 400.00
ri^2 = 359.86
ro^2–ri^2 = 400.00 – 359.86
ro^2–ri^2 = 40.14 cm2

area of steel bar
As = 8 ø 16 --Ø 16
8.00 x 2.0106 = 16.08 cm2

As = 16.08 cm2

$Ys = \frac{\text{Area of bar.Y bar}}{\text{Area of bar}}$

$= \frac{16.08 \times 18.97}{16.08}$

$= \frac{305.13}{16.08}$

= 18.97 cm

$n = \frac{1,897,200}{242,201}$

= 7.83

$p = \frac{\text{tot.A rea of steel bar}}{@pi.ro^2}$

$= \frac{16.08}{3.14 \times 400.00}$

$= \frac{16.08}{1,256.64}$

p = 0.01280

n.p = 7.83 x 0.01280

= 1.54810

$alpa = \frac{ri}{ro} = \frac{18.97}{20.00} = 0.95$

e = (7.54) cm

$\frac{e}{ro} = \frac{(7.54)}{20.00} = (0.3768)$

$\frac{e}{ro} = \frac{pi/4 - (5/12 - 1/6.\cos^2 pi)\sin pi.\cos pi + (n.@pi.p)/2.(ri/ro)^2}{\sin pi/3.(2 + \cos^2 pi) - pi.\cos pi - n.@pi.p \cos pi}$

trial value of pi --->>>> pi = 1.0461 degree
pi = 0.0183 rad.

e = pi/4 – (5/12 – 1/6.cos^2 pi)sin pi.cos pi + (n.@pi.p)/2.(alpa)^2

pi/4 = A	=	0.0183	:	4.00 =	0.00	
n	=	7.83				
alpa	=	0.95 cm				
alpa^2	=	0.90 cm^2				
cos pi	=	0.999833				
Sin pi	=	0.018257				
Cos^2 pi	=	0.999667				
1/6.cos^2 pi	=	0.166667	x	0.999667 =	0.16661	
(5/12 – 1/6.cos^2 pi)	=	0.416667	–	0.166611 =	0.250056	
Sin pi cos pi	=	0.018257	x	0.999833 =	0.02	
(5/12 – 1/6.cos^2 pi) x sin pi.cos pi = B	=	0.25006	x	0.99983	=	0.25001
(n.@pi.p)	=	1.55	x	3.14 =	4.86	
(n.@pi.p)/2	=	4.86	:	2.00 =	2.43	
(n.@pi.p)/2 x (alpa)^2 = C	=	2.43	x	0.90	=	2.19
sum A – B + C	=	0.00	–	0.25 +	2.19 =	1.94

ro = sin pi/3.(2 + cos^2 pi)–pi.cos pi – n.@pi.p cos pi

(Sin pi)/3	=	0.006				
(2 + cos^2 pi)	=	2.000	+	1.000 =	3.000	
sin ø/3 x (2 + cos^2 pi)	=	0.006	x	3.000	=	0.018

III.1.7 Control stresses on pile
Normal Condition
III.1.7.1 Case – I High Water Level

pi.cos pi	=	0.018	x	1.000			=	0.018
n.@pi.p	=	1.548	x	3.142	=	4.864		
n.@pi.p cos pi	=	4.864	x	1.000			=	4.863
							=	(4.863)

$$\frac{e}{ro} = \frac{1.94}{(4.86)} \qquad pi = 1.05 \text{ rad}$$

$$\frac{e}{ro} = (0.3994) \qquad \frac{e}{ro} = (0.3768)$$

$$C = \frac{1 - \cos pi}{2\sin^3 pi/3 - pi\cos pi + \sin pi\cos^2 pi + pi/4 - \sin pi.\cos pi/4 - \sin^3.pi.\cos pi/6 \ @pi.np.(alpa^2/2 - \cos pi)}$$

Cos pi	=	1.000						
sin pi	=	0.018						
sin^3 pi	=	0.000						
sin pi.cos pi	=	0.018	x	1.000	=	0.018		
Cos ^ 2pi	=	1.000						
1 – cos pi	=	1.000	–	1.000	=	0.000		
2.sin^3 pi	=	2.000	x	0.000	=	0.000		
2.sin^3 pi/3 = A	=	0.000	:	3.000			=	0.000
pi.cos pi = B	=	0.018	x	1.000			=	0.018
sin pi.cos^2 pi = C	=	0.018	x	1.000			=	0.018
pi/4 = D	=	0.005					=	0.005
Cos pi/4	=	1.000	:	4.000	=	0.250		
sin pi.cos pi/4 = E	=	0.018	x	0.250			=	0.005
(sin^3 pi.cos pi)	=	0.000	x	1.000	=	0.000		
(sin^3 pi.cos pi)/6 = F	=	0.000	:	6.000			=	0.000
n.p	=	1.548						
@pi.np	=	3.142	x	1.548	=	4.864		
alpa	=	0.948						
alpa^2	=	0.900						
alpa^2/2	=	0.900	:	2.000	=	0.450		
alpa^2/2 – cos pi	=	0.450	–	1.000	=	(0.550)		
@pi.np x alpa^2/2	=	4.864	x	0.450	=	2.188		
@pi.np x alpa^2/2 – cos ø = G	=	2.188	–	1.000			=	1.188
sum = A – B + C + D – E – F + G							=	1.188

$$C = \frac{1 - \cos pi}{2\sin^3 pi/3 - pi\cos pi + \sin pi\cos^2 pi + pi/4 - \sin pi.\cos pi/4 - \sin^3.pi.\cos pi/6 \ @pi.np.(alpa^2/2 - \cos pi)}$$

$$C = \frac{0.000167}{1.188} = 0.00014$$

$$S = C \times \frac{alpa + \cos pi}{1 - \cos pi}$$

$$= 0.000 \times \frac{0.948 + 1.000}{0.000}$$

$$= 0.000 \times 11{,}689.476$$

$$= 1.640$$

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – F5		Nos of sheet
Station	: FW 33 + 65		Prepared by

III.1.7 Control stresses on pile
Normal Condition
III.1.7.1 Case – I High Water Level

teg–n

M'	=	428,400	kg.cm	
ro	=	20.000	cm	

stres on concrete = fc

$$fc = \frac{M'}{ro^3} \times C$$

$$= \frac{428{,}400}{8{,}000} \times 0.000$$

$$= 53.550 \times 0.000$$

$$= 0.01 \text{ kg/cm2} > 70 \text{ kg/cm2}$$

stres on steel = fs

$$fs = \frac{M'}{ro^3} \times S \times n$$

$$= \frac{428{,}400}{8{,}000} \times 1.640 \times 8 \text{ kg/cm2}$$

$$= 53.550 \times 1.640 \times 8 \text{ kg/cm2}$$

$$= 688 \text{ kg/cm2}$$

teg–n

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Normal Condition

III.1.8.1 Case – I, High Water Level

Ka	=	0.297		Ywet	=	1.850	t/m3
Ht	=	7.500	m	Ysat	=	2.000	t/m3
W	=	19.00	m	Yw	=	1.000	t/m3
q	=	1.000	t/m2	Yc	=	2.400	t/m3
alpha	=	43.90	degree	sin alpha	=	0.693	degree
				skew width	=	27.40	m

Description	Total load (ton) Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
weight	932.63	54.55	307.42	18.60	1313.20	27.40
per Abt.	466.315	27.275	153.7	9.30	656.6	
per m'	17.018	0.995	5.610	0.339	23.963	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description Y (m)	x	Hn (m)	x	Wn (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Yo (m)
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400				
			q	x	H									
Pq	=		1.00	x	1.945			=	1.945		1.945		0.973	1.892
Pa1		0.5 x	Y	x	H1^2	x	Ka							
	=	0.5 x	1.85	x	3.78	x	0.297	=	1.039		1.039		0.648	
total										1.400	2.984			1.892

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description Ye (m)	x	H (m)	x	W (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Yo (t.m)
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400		0.150		0.210
C2	=		2.40	x	0.500	x	0.55	=	0.660	0.660		0.275		0.182
C3	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330		0.275		0.091
E1	=		q	x	H	x	W							
	=		1.00	x	1.945	x	0.25	=	0.486	0.486		0.275		0.134
total										2.877				0.616

Section 3 – 3

Pe = 0.000 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.500 m	W7	=	0.200 m			

mqh-1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Normal Condition

III.1.8.1 Case – I, High Water Level

Load		W Description Y (m)	x	H (m)	x	W (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M (t.m)
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400				
C4	=		2.40	x	1.000	x	1.00	=	2.400	2.400				
C5	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=		2.40	x	0.500	x	0.55	=	0.660	0.660				
C6	=		2.40	x	0.500	x	0.20	=	0.240	0.240				
C7	=	0.5 x	2.40	x	0.500	x	0.20	=	0.120	0.120				
Pe								=	0.00		0.00		1.00	0.00
Pq	=		1.00	x	2.445			=	2.445		2.445		1.223	2.989
Pa	=	0.5 x	1.85	x	2.445	x	0.297	=	0.672		0.672		0.815	0.547
Rv	=								23.963	*******				
sum										*******	3.117			3.536

Section 4 – 4

Top deck elv	=	39.9 m				
Hwl elv.	=	32.05 m				
H back fill	=	Ht	–	H3		
	=	7.50	–	1.00	=	6.50 m
Top footing elv.	=	39.900	–	6.500	=	33.400 m
	=	39.9	–	32.05	=	7.850 m under footing
H wet soil	=	39.9	–	33.4	=	6.500 m
H sat soil	=	6.50	–	6.5	=	0 m

H1	=	1.945 m	W1	=	0.300 m
H2	=	4.555 m	W2	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m
H5	=	0.500 m	W5	=	0.550 m
H6	=	0.500 m	W6	=	0.200 m
H7	=	0.500 m	W7	=	0.200 m

H wet = 6.5 : 3 + 0 = 2.167 m

Load		Description Y (m)	x	Hn (m)	x	Wn (m)	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Ho.Yo (t.m)
C1	=		2.40	x	1.95	x	0.30 =	1.400	1.400			
C4	=		2.40	x	1.00	x	1.00 =	2.400	2.400			
C5	=	0.5 x	2.40	x	0.50	x	0.55 =	0.330	0.330			
C2	=		2.40	x	0.50	x	0.55 =	0.660	0.660			
C6	=		2.40	x	1.00	x	0.20 =	0.480	0.480			
C7	=	0.5 x	2.40	x	0.50	x	0.20 =	0.120	0.120			
Pe							=	0		0.000		4.555	0.000
Pq1	=		1.00	x	6.50		=	6.500		6.500		3.250	21.125
Pw1	=	0.5 x	1.85	x	42.250	x	0.297 =	11.607		11.607		2.167	25.149
Ps1	=	0.5 x	2.00	x	0.000	x	0.297 =	0.000		0.000		0.000	0.000
Ps2			2.00	x	0	x	0.297 =	0.000		0.000		0.000	0.000
Pwl	=	0.5 x	1.00	x	0.090		=	0.045		0.045		0.100	0.005
Pwr	=	0.5 x	1.00	x	0.000		=	0.000		0.000		0.000	0.000
Rv	=							23.963	*******				
sum									*******	18.152			46.278

mqh-1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Normal Condition

III.1.8.1 Case – I, High Water Level

Section 5 – 5

H1	=	0.300 m	W1	=	1.80 m		
H2	=	1.000 m	W2	=	1.80 m		
H wet.r	=	6.500 –	1.945	=	4.56 m		
H sat.r	=	0.000 m					

Load		Description							Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		Y	x	H	x	W	=							
		m		m		t/m3			ton	ton	ton	m	m	t.m
C1	=	0.5 x	2.40	x	0.30	x	1.80	=	0.648	0.648		0.600		0.389
C2	=		2.40	x	1.00	x	1.80	=	4.320	4.320		0.900		3.888
E1(wet)	=		1.85	x	4.56	x	1.80	=	15.168	15.168		0.900		13.651
E1(sat)	=		2.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
U1(up lift)	=		1.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
Rp 4								=	(32.050)	(32.050)		1.175		(37.659)
Rp 3								=	(31.490)	(31.490)		0.000		0.000
		total						=		(43.404)				(19.731)

Section 6 – 6

H 3.1	=	0.300 m	W1	=	2.30 m		
H 3.2	=	1.000 m	W2	=	2.30 m		
H wet	=	6.500 m					
H sat	=	0.000 m					

Load		Description							Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		Y	x	H	x	W	=							
		m		m		t/m3			ton	ton	ton	m	m	t.m
C 3.1	=	0.5 x	2.40	x	0.300	x	2.30	=	0.828	0.828		0.767		0.635
C 3.2	=		2.40	x	1.000	x	2.30	=	5.520	5.520		1.150		6.348
E1(wet)	=		1.85	x	6.500	x	2.30	=	27.658	27.658		1.150		31.806
E1(sat)	=		2.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
U1(up lift)	=		1.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
Rp 1								=	(34.500)	(34.500)		1.675		(57.787)
Rp 2								=	(33.000)	(33.000)		0.425		(14.025)
		total						=		(33.495)				(33.024)

mqh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Normal Condition

III.1.8.2 Case – II, Low Water Level

Ka	=	0.297	Ywet	=	1.850 t/m3
Ht	=	7.500 m	Ysat	=	2.000 t/m3
W	=	19.00 m	Yw	=	1.000 t/m3
q	=	1.000 t/m2	Yc	=	2.400 t/m3
alpha	=	43.90 degree	sin alpha	=	0.693 degree
			skew width	=	27.40 m

Description	Total load (ton)					
	Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
weight	932.63	54.55	307.42	18.60	1313.20	27.40
per Abt.	466.315	27.275	153.7	9.30	656.6	
per m'	17.018	0.995	5.610	0.339	23.963	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description								Weight	Vo	Ho	Xo	Yo	M = Vo.Yo
		Y	x	Hn	x	Wn	=								
		m		m		t/m3				ton	ton	ton	m	m	m
C1	=		2.40	x	1.945	x	0.30	=		1.400	1.400				
		q	x	H											
Pq	=		1.00	x	1.945			=		1.945		1.945		0.973	1.892
Pa1		0.5 x	Y	x	H1^2	x	Ka								
	=	0.5 x	1.85	x	3.78	x	0.297	=		1.039		1.039		0.648	
		total									1.400	2.984			1.892

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description								Weight	Vo	Ho	Xo	Yo	M = Vo.Yo
		Yc	x	H	x	W	=								
		m		m		t/m3				ton	ton	ton	m	m	t.m
C1	=		2.40	x	1.945	x	0.30	=		1.400	1.400		0.150		0.210
C2	=		2.40	x	0.500	x	0.55	=		0.660	0.660		0.275		0.182
C3	=	0.5 x	2.40	x	0.500	x	0.55	=		0.330	0.330		0.275		0.091
E1	=		q	x	H	x	W								
	=		1.00	x	1.945	x	0.25	=		0.486	0.486		0.275		0.134
		total									2.877				0.616

Section 3 – 3

Pe = 0.000 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.500 m	W7	=	0.200 m			

mqh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section
Normal Condition
III.1.8.2 Case – II, Low Water Level

Load		W	Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M
			m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400				
C4	=		2.40	x	1.000	x	1.00	=	2.400	2.400				
C5	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=		2.40	x	0.500	x	0.55	=	0.660	0.660				
C6	=		2.40	x	0.500	x	0.20	=	0.240	0.240				
C7	=	0.5 x	2.40	x	0.500	x	0.20	=	0.120	0.120				
Pe								=	0.00		0.00		1.00	0.00
Pq	=		1.00	x	2.445			=	2.445		2.445		1.223	2.989
Pa	=	0.5 x	1.85	x	2.445	x	0.297	=	0.672		0.672		0.815	0.547
Rv	=								23.963	23.963				
		sum								29.113	3.117			3.536

Section 4 – 4

Top deck elv	=	39.9	m				
Lwl elv.	=	28.18	m				
H back fill	=	Ht	–	H3			
	=	7.50	–	1.00	=	6.50	m
Top footing elv.	=	39.900	–	6.500	=	33.400	m
	=	39.9	–	28.18	=	11.720	m under footing
H wet soil	=	39.9	–	33.4	=	6.500	m
H sat soil	=	6.50	–	6.5	=	0	m

H1	=	1.945	m	W1	=	0.300	m
H2	=	4.555	m	W2	=	1.000	m
H4	=	0.500	m	W4	=	0.550	m
H5	=	0.500	m	W5	=	0.550	m
H6	=	0.500	m	W6	=	0.200	m
H7	=	0.500	m	W7	=	0.200	m
H wet	=	6.5	:	3	+	0	= 2.167 m

Load		Description Y	x	Hn	x	Wn	Weight	Vo	Ho	Xo	Yo	M = Ho.Yo
		m		m		m	ton	ton	ton	m	m	t.m
C1	=	2.40	x	1.95	x	0.30	= 1.400	1.400				
C4	=	2.40	x	1.00	x	1.00	= 2.400	2.400				
C5	= 0.5 x	2.40	x	0.50	x	0.55	= 0.330	0.330				
C2	=	2.40	x	0.50	x	0.55	= 0.660	0.660				
C6	=	2.40	x	1.00	x	0.20	= 0.480	0.480				
C7	= 0.5 x	2.40	x	0.50	x	0.20	= 0.120	0.120				
Pe							= 0		0.000		4.55	0.000
Pq1	=	1.00	x	6.50			= 6.500		6.500		3.250	21.125
Pw1	= 0.5 x	1.85	x	42.250	x	0.297	= 11.607		11.607		2.167	25.149
Ps1	= 0.5 x	2.00	x	0.000	x	0.297	= 0.000		0.000		0.000	0.000
Ps2		2.00	x	0	x	0.297	= 0.000		0.000		0.000	0.000
Pwl	= 0.5 x	1.00	x	0.090			= 0.045		0.045		0.100	0.005
Pwr	= 0.5 x	1.00	x	0.000			= 0.000		0.000		0.000	0.000
Rv	=						23.963	23.963				
	sum							29.353	18.152			46.278

mqh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section
Normal Condition
III.1.8.2 Case – II, Low Water Level

Section 5 – 5

H1	=	0.300	m	W1	=	1.80	m
H2	=	1.000	m	W2	=	1.80	m
H wet.r	=	6.500	–	1.945	=	4.56	m
H sat.r	=	0.000	m				

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	0.5 x 2.40	x	0.30	x	1.80	=	0.648	0.648		0.600		0.389
C2	=	2.40	x	1.00	x	1.80	=	4.320	4.320		0.900		3.888
E1(wet)	=	1.85	x	4.56	x	1.80	=	15.168	15.168		0.900		13.651
E1(sat)	=	2.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
U1(up lift)	=	1.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
Rp 4							=	(32.050)	(32.050)		1.175		(37.659)
Rp 3							=	(31.490)	(31.490)		0.000		0.000
		total					=		(43.404)				(19.731)

Section 6 – 6

H 3.1	=	0.300	m	W1	=	2.30	m
H 3.2	=	1.000	m	W2	=	2.30	m
H wet	=	6.500	m				
H sat	=	0.000	m				

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C 3.1	=	0.5 x 2.40	x	0.300	x	2.30	=	0.828	0.828		0.767		0.635
C 3.2	=	2.40	x	1.000	x	2.30	=	5.520	5.520		1.150		6.348
E1(wet)	=	1.85	x	6.500	x	2.30	=	27.658	27.658		1.150		31.806
E1(sat)	=	2.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
U1(up lift)	=	1.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
Rp 1							=	(34.500)	(34.500)		1.675		(57.787)
Rp 2							=	(33.000)	(33.000)		0.425		(14.025)
		total					=		(33.495)				(33.024)

mqh–2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Earthquake condition

III.1.8.3 Case – III, High Water Level

Ka	=	0.407	Ywet	=	1.850 t/m3
Ht	=	7.500 m	Ysat	=	2.000 t/m3
W	=	19.00 m	Yw	=	1.000 t/m3
q	=	0.500 t/m2	Yc	=	2.400 t/m3
alpha	=	43.90 degree	sin alpha	=	0.693 degree
			skew width	=	27.40 m

Description	Total load (ton) Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
weight	932.63	54.55	307.42	18.60	1313.20	27.40
per Abt.	466.315	27.275	153.7	9.30	656.6	
per m'	17.018	0.995	5.610	0.339	23.963	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description												M = Vo.Yo
		Y	x	Hn	x	Wn	=	Weight	Vo	Ho	Xo	Yo	
		m		m		t/m3		ton	ton	ton	m	m		m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400					
		q	x	H										
Pq	=	0.50	x	1.945			=	0.973		0.973		0.973		0.946
Pa1		0.5 x	Y	x	H1^2	x	Ka							
	=	0.5 x	1.85	x	3.78	x	0.407	=	1.424		1.424		0.648	
		total							1.400	2.397				0.946

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description												M = Vo.Yo
		Yc	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	
		m		m		t/m3		ton	ton	ton	m	m		t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400		0.150			0.210
C2	=	2.40	x	0.500	x	0.55	=	0.660	0.660		0.275			0.182
C3	= 0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330		0.275			0.091
E1	=	q	x	H	x	W								
	=	0.50	x	1.945	x	0.25	=	0.243	0.243		0.275			0.067
		total							2.634					0.549

Section 3 – 3

Pe = 3.063 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.500 m	W7	=	0.200 m			

mqh–3

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Earthquake condition

III.1.8.3 Case – III, High Water Level

Load		W Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400				
C4	=	2.40	x	1.000	x	1.00	=	2.400	2.400				
C5	= 0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=	2.40	x	0.500	x	0.55	=	0.660	0.660				
C6	=	2.40	x	0.500	x	0.20	=	0.240	0.240				
C7	= 0.5 x	2.40	x	0.500	x	0.20	=	0.120	0.120				
Pe							=	3.06		3.06		1.00	3.06
Pq	=	0.50	x	2.445			=	1.223		1.223		1.223	1.495
Pa	= 0.5 x	1.85	x	2.445	x	0.407	=	0.920		0.920		0.815	0.750
Rv	=							23.963	23.963				
		sum							29.113	5.206			5.308

Section 4 – 4

Top deck elv	=	39.9 m					
Hwl elv.	=	32.05 m					
H back fill	=	Ht	–	H3			
	=	7.50	–	1.00	=	6.50 m	
Top footing elv.	=	39.900	–	6.500	=	33.400 m	
	=	39.9	–	32.05	=	7.850 m	under footing
H wet soil	=	39.9	–	33.4	=	6.500 m	
H sat soil	=	6.50	–	6.5	=	0 m	

H1	=	1.945 m	W1	=	0.300 m		
H2	=	4.555 m	W2	=	1.000 m		
H4	=	0.500 m	W4	=	0.550 m		
H5	=	0.500 m	W5	=	0.550 m		
H6	=	0.500 m	W6	=	0.200 m		
H7	=	0.500 m	W7	=	0.200 m		
H wet	=	6.5	:	3	+	0 =	2.167 m

Load		Description Y	x	Hn	x	Wn	Weight	Vo	Ho	Xo	Yo	M = Ho.Yo
		m		m		m	ton	ton	ton	m	m	t.m
C1	=	2.40	x	1.95	x	0.30 =	1.400	1.400				
C4	=	2.40	x	1.00	x	1.00 =	2.400	2.400				
C5	= 0.5 x	2.40	x	0.50	x	0.55 =	0.330	0.330				
C2	=	2.40	x	0.50	x	0.55 =	0.660	0.660				
C6	=	2.40	x	1.00	x	0.20 =	0.480	0.480				
C7	= 0.5 x	2.40	x	0.50	x	0.20 =	0.120	0.120				
Pe						=	3.063		3.063		4.555	13.952
Pq1	=	0.50	x	6.50		=	3.250		3.250		3.250	10.563
Pw1	= 0.5 x	1.85	x	42.250	x	0.407 =	15.906		15.906		2.167	34.463
Ps1	= 0.5 x	2.00	x	0.000	x	0.407 =	0.000		0.000		0.000	0.000
Ps2		2.00	x	0	x	0.407 =	0.000		0.000		0.000	0.000
Pwl	= 0.5 x	1.00	x	0.090		=	0.045		0.045		0.100	0.005
Pwr	= 0.5 x	1.00	x	0.000		=	0.000		0.000		0.000	0.000
Rv	=						23.963	23.963				
		sum						29.353	22.264			58.982

mqh–3

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section
Earthquake condition
III.1.8.3 Case – III, High Water Level

Section 5 – 5

H1	=	0.300 m	W1	=	1.80 m	
H2	=	1.000 m	W2	=	1.80 m	
H wet.r	=	6.500 –	1.945	=	4.56 m	
H sat.r	=	0.000 m				

Load		Description: Y (m)	x	H (m)	x	W (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Xo (t.m)
C1	=	0.5	x	2.40	x	0.30	x	1.80 =	0.648	0.648		0.600		0.389
C2	=			2.40	x	1.00	x	1.80 =	4.320	4.320		0.900		3.888
E1(wet)	=			1.85	x	4.56	x	1.80 =	15.168	15.168		0.900		13.651
E1(sat)	=			2.00	x	0.000	x	1.80 =	0.000	0.000		0.900		0.000
U1(up lift)	=			1.00	x	0.000	x	1.80 =	0.000	0.000		0.900		0.000
Rp 4								=	(22.310)	(22.310)		1.175		(26.214)
Rp 3								=	(26.840)	(26.840)		0.000		0.000
total								=		(29.014)				(8.286)

Section 6 – 6

H 3.1	=	0.300 m	W1	=	2.30 m	
H 3.2	=	1.000 m	W2	=	2.30 m	
H wet	=	6.500 m				
H sat	=	0.000 m				

Load		Description: Y (m)	x	H (m)	x	W (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Xo (t.m)
C 3.1	=	0.5	x	2.40	x	0.300	x	2.30 =	0.828	0.828		0.767		0.635
C 3.2	=			2.40	x	1.000	x	2.30 =	5.520	5.520		1.150		6.348
E1(wet)	=			1.85	x	6.500	x	2.30 =	27.658	27.658		1.150		31.806
E1(sat)	=			2.00	x	0.000	x	2.30 =	0.000	0.000		1.150		0.000
U1(up lift)	=			1.00	x	0.000	x	2.30 =	0.000	0.000		1.150		0.000
Rp 1								=	(45.640)	(45.640)		1.675		(76.447)
Rp 2								=	(36.240)	(36.240)		0.425		(15.402)
total								=		(47.875)				(53.060)

mqh–3

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section
Earthquake condition
III.1.8.4 Case – IV, Low Water Level

Ka	=	0.407	Ywet	=	1.850 t/m3
Ht	=	7.500 m	Ysat	=	2.000 t/m3
W	=	19.00 m	Yw	=	1.000 t/m3
q	=	0.500 t/m2	Yc	=	2.400 t/m3
alpha	=	43.90 degree	sin alpha	=	0.693 degree
			skew wic	=	27.40 m

Description	Total load (ton) Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
weight	932.63	54.55	307.42	18.60	1313.20	27.40
per Abt.	466.315	27.275	153.71	9.30	656.6	
per m'	17.018	0.995	5.610	0.339	23.963	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description: Y (m)	x	Hn (m)	x	Wn (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Yo (m)
C1	=			2.40	x	1.945	x	0.30 =	1.400	1.400			
				q	x	H							
Pq	=			0.50	x	1.945		=	0.973		0.973	0.973	0.946
Pa1		0.5	x	Y	x	H1^2	x	Ka					
	=	0.5	x	1.85	x	3.78	x	0.407 =	1.424		1.424	0.648	
total										1.400	2.397		0.946

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m	
H4	=	0.500 m	W4	=	0.55 m	
H5	=	0.500 m	W5	=	0.55 m	

Load		Description: Yc (m)	x	H (m)	x	W (t/m3)	=	Weight (ton)	Vo (ton)	Ho (ton)	Xo (m)	Yo (m)	M = Vo.Yo (t.m)
C1	=			2.40	x	1.945	x	0.30 =	1.400	1.400		0.150		0.210
C2	=			2.40	x	0.500	x	0.55 =	0.660	0.660		0.275		0.182
C3	=	0.5	x	2.40	x	0.500	x	0.55 =	0.330	0.330		0.275		0.091
E1	=			q	x	H	x	W						
	=			0.50	x	1.945	x	0.25 =	0.243	0.243		0.275		0.067
total										2.634				0.549

Section 3 – 3

Pe = 3.063 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.500 m	W7	=	0.200 m			

mqh–4

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Earthquake condition

III.1.8.4 Case – IV, Low Water Level

Load		W	Description					Vo	Ho	Xo	Yo	M
		Y	x	H	x	W	= Weight					
		m		m		t/m3	ton	ton	ton	m	m	t.m
C1	=			2.40	x	1.945	x 0.30 = 1.400	1.400				
C4	=			2.40	x	1.000	x 1.00 = 2.400	2.400				
C5	=	0.5	x	2.40	x	0.500	x 0.55 = 0.330	0.330				
C2	=			2.40	x	0.500	x 0.55 = 0.660	0.660				
C6	=			2.40	x	0.500	x 0.20 = 0.240	0.240				
C7	=	0.5	x	2.40	x	0.500	x 0.20 = 0.120	0.120				
Pe							= 3.06		3.06		1.00	3.06
Pq	=			0.50	x	2.445	= 1.223		1.223		1.223	1.495
Pa	=	0.5	x	1.85	x	2.445	x 0.407 = 0.920		0.920		0.815	0.750
Rv	=						23.963	23.963				
		sum						29.113	5.206			5.308

Section 4 – 4

Top deck elv	=	39.9	m				
Lwl elv.	=	28.18	m				
H back fill	=	Ht	–	H3			
	=	7.50	–	1.00	=	6.50	m
Top footing elv.	=	39.900	–	6.500	=	33.400	m
	=	39.9	–	28.18	=	11.720	m under footing
H wet soil	=	39.9	–	33.4	=	6.500	m
H sat soil	=	6.50	–	6.5	=	0	m

H1	=	1.945	m	W1	=	0.300	m
H2	=	4.555	m	W2	=	1.000	m
H4	=	0.500	m	W4	=	0.550	m
H5	=	0.500	m	W5	=	0.550	m
H6	=	0.500	m	W6	=	0.200	m
H7	=	0.500	m	W7	=	0.200	m

H wet = 6.5 : 3 + 0 = 2.167 m

Load		Description							Vo	Ho	Xo	Yo	M = Ho.Yo
		Y	x	Hn	x	Wn		Weight					
		m		m		m		ton	ton	ton	m	m	t.m
C1	=			2.40	x	1.95	x	0.30 = 1.400	1.400				
C4	=			2.40	x	1.00	x	1.00 = 2.400	2.400				
C5	=	0.5	x	2.40	x	0.50	x	0.55 = 0.330	0.330				
C2	=			2.40	x	0.50	x	0.55 = 0.660	0.660				
C6	=			2.40	x	1.00	x	0.20 = 0.480	0.480				
C7	=	0.5	x	2.40	x	0.50	x	0.20 = 0.120	0.120				
Pe								= 3.063		3.063		4.555	13.952
Pq1	=			0.50	x	6.50		= 3.250		3.250		3.250	10.563
Pw1	=	0.5	x	1.85	x	42.250	x	0.407 = 15.906		15.906		2.167	34.463
Ps1	=	0.5	x	2.00	x	0.000	x	0.407 = 0.000		0.000		0.000	0.000
Ps2				2.00	x	0	x	0.407 = 0.000		0.000		0.000	0.000
Pw1	=	0.5	x	1.00	x	0.090		= 0.045		0.045		0.100	0.005
Pwr	=	0.5	x	1.00	x	0.000		= 0.000		0.000		0.000	0.000
Rv	=							23.963	23.963				
		sum							29.353	22.264			58.982

mqh–4

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F5		Nos of sheet	
Station	: Fw 33 + 65		Prepared by	

III.1.8 Combined load at Abutment section

Earthquake condition

III.1.8.4 Case – IV, Low Water Level

Section 5 – 5

H1	=	0.300	m	W1	=	1.80	m
H2	=	1.000	m	W2	=	1.80	m
H wet.r	=	6.500	–	1.945	=	4.56	m
H sat.r	=	0.000	m				

Load		Description							Vo	Ho	Xo	Yo	M = Vo.Xo
		Y	x	H	x	W	=	Weight					
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	0.5	x	2.40	x	0.30	x	1.80 = 0.648	0.648		0.600		0.389
C2	=			2.40	x	1.00	x	1.80 = 4.320	4.320		0.900		3.888
E1(wet)	=			1.85	x	4.56	x	1.80 = 15.168	15.168		0.900		13.651
E1(sat)	=			2.00	x	0.000	x	1.80 = 0.000	0.000		0.900		0.000
U1(up lift)	=			1.00	x	0.000	x	1.80 = 0.000	0.000		0.900		0.000
Rp 4								= (32.050)	(32.050)		1.175		(37.659)
Rp 3								= (31.490)	(31.490)		0.000		0.000
		total						=	(43.404)				(19.731)

Section 6 – 6

H 3.1	=	0.300	m	W1	=	2.30	m
H 3.2	=	1.000	m	W2	=	2.30	m
H wet	=	6.500	m				
H sat	=	0.000	m				

Load		Description							Vo	Ho	Xo	Yo	M = Vo.Xo
		Y	x	H	x	W	=	Weight					
		m		m		t/m3		ton	ton	ton	m	m	t.m
C 3.1	=	0.5	x	2.40	x	0.300	x	2.30 = 0.828	0.828		0.767		0.635
C 3.2	=			2.40	x	1.000	x	2.30 = 5.520	5.520		1.150		6.348
E1(wet)	=			1.85	x	6.500	x	2.30 = 27.658	27.658		1.150		31.806
E1(sat)	=			2.00	x	0.000	x	2.30 = 0.000	0.000		1.150		0.000
U1(up lift)	=			1.00	x	0.000	x	2.30 = 0.000	0.000		1.150		0.000
Rp 1								= (34.500)	(34.500)		1.675		(57.787)
Rp 2								= (33.000)	(33.000)		0.425		(14.025)
		total						=	(33.495)				(33.024)

mqh–4

Project : Medan Flood Control Channel : Percut River Structure : For all Bridge	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

Allowance stresses

Unit compersion	1	Mpa	=	10.20 kg/cm2
	1	kg/cm2	=	0.098 Mpa
	1	kN	=	102.00 kg

A. CONCRETE

concrete cilynder charateristic at 28 daya

Allowance stress in concrete in prestressed flexural members.

a Stresses immediately after prestres transfer, (before prestress losses)

concrete K.400

f'c = 400.00 kg/cm2
= 39.22 Mpa

f'ci = 0.80 x f'c Mpa
= 0.80 x 39.22
= 31.37 Mpa
= 31.37 x 10.20
= 320.0 kg/cm2

Extreme fiber stress in compression from ACI 318-77

fci = 0.60 x f'ci Mpa
= 0.60 x 31.37
= 18.82 Mpa
= 18.82 x 10.20
= 192.00 kg/cm2

Extreme fiber stress in tension from ACI 318-77

fti = −0.25 x @ sqrt(f'ci) Mpa
= (0.25) x 5.60
= (1.40) Mpa
= (1.40) x 10.20
= (14.28) kg/cm2

b Stresses at sercice load (after allowance for all prestres losses)

service load K.400

f'c = 400.00 kg/cm2
= 39.22 Mpa

extreem fiber stress in compression

fcs = 0.45 x fc Mpa
= 0.45 x 39.22
= 17.65 Mpa
= 17.65 x 10.20
= 180.00 kg/cm2

extreem fiber stress in tension

fts = −0.5 x @sqrt(f'c) Mpa
= (0.500) x 5.26
= (3.13) Mpa
= (3.13) x 10.20
= (31.94) kg/cm2

Modulus of elasticity

alw-stres

Project : Medan Flood Control Channel : Percut River Structure : For all Bridge	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

a Concrete class K.400

f'c = 400.00 kg/cm2
= 39.22 Mpa

a.1 Permanent load

Ec = Yc^1.5x(0.043x@sqrt(f'c)
Yc = 2,500 kg/cm2
= 125,000 x 0.043 x @sqrt(f'c)
= 5,375 x 6.262
= 33,659.56 Mpa
= 33,659.56 x 10.20
= 343,327.47 kg/cm2

b.1 Temporary load

Ec = 1.50 x 343,327
= 514,991 kg/cm2

b Concrete class K.350

b.1 Permanent load f'c = 350.00 kg/cm2
= 34.31 Mpa

Ec = Yc^1.5x(0.043x@sqrt(f'c)
Yc = 2,500 kg/cm2
= 125,000 x 0.043 x @sqrt(f'c)
= 5,375 x 5.858
= 31,486 Mpa
= 31,486 x 10.20
= 321,153 kg/cm2

b.2 Temporary load

Ec = 1.50 x 321,153.44
= 481,730 kg/cm2

c Concrete class K.225

f'c = 225.00 kg/cm2
= 22.06 Mpa

c.1 Permanent load Ec = Yc^1.5x(0.043x@sqrt(f'c)
Yc = 2,500 kg/cm2
= 125,000 x 0.043 x @sqrt(f'c)
= 5,375 x 4.697
= 25,244.67 Mpa
= 25,244.67 x 5.86
= 147,878 kg/cm2

c.2 Temporary load

Ec = 1.50 x 147,878.00
= 221,817 kg/cm2

B. STEEL

Elasticity of strand (ASTM A 416)

Es = 186,000 Mpa
= 186,000 x 10.20
= 1,897,200 kg/cm2

nominal diameter = 12.70 mm
nominal area = 92.40 mm2
= 0.9240 cm2

alw-stres

Project : Medan Flood Control Channel : Percut River Structure : For all Bridge	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

allowance stresses in prestressing tendon

grade			270		
fu	=	1,860	Mpa		
	=	1,860	x		10.20
	=	18,972	kg/cm2		
at jacking	=	0.80	x	fu	
	=	0.80	x	18,972	
	=	15,178	kg/cm2		
after tranfer	=	0.70	x	fu	
	=	0.70	x	18,972	
	=	13,280	kg/cm2		
effective presttressing	=	0.60	x	fu	
	=	0.60	x	18,972	
	=	11,383	kg/cm2		
Breaking load	=	As	x	fu	
	=	0.924	x	18,972	
	=	17,530	kg/cm2		
	=	171.86	kN		
say	=	172	kN		

Jacking forces

nos of strand	area of strand cm2	allowance stress of strand kg/cm2	jacking forces kg
1.00	0.9240	15,178	14,024
2.00	0.9240	15,178	28,048
3.00	0.9240	15,178	42,072
4.00	0.9240	15,178	56,096
5.00	0.9240	15,178	70,121
6.00	0.9240	15,178	84,145
7.00	0.9240	15,178	98,169
8.00	0.9240	15,178	112,193
9.00	0.9240	15,178	126,217
10.00	0.9240	15,178	140,241

alw-stres

PRESTRESSED CONCRETE BRIDGE COMPUTATION
CHANNEL MEDAN FLOOD WAY
Br – Mf 3
Station : Fw 28 + 22

span
31.00

Width
9.0 m

II SUB STRUCTURE

Abutment

- II.1 Neutral axis of Abutment
- II.2 Earthquake coefficient
- II.3 Axial forces on Abutment
- II.4 Coulumb coefficient
- II.5 Horizontal force
  - II.5.1 Case – I,Normal condition (HWL)
  - II.5.2 Case – II,Normal condition (LWL)
  - II.5.3 Case – III,Earthquake condition (HWL)
  - II.5.4 Case – IV,Earthquake condition (LWL)
- II.6 Combined Load on Abutment
  - II.6.1 Case – I,Normal condition (HWL)
  - II.6.2 Case – II,Normal condition (LWL)
  - II.6.3 Case – III,Earthquake condition (HWL)
  - II.6.4 Case – IV,Earthquake condition (LWL)

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F3 Station : FW 28 + 22 m	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II ABUTMENT

II.1 Neutral axis

depth of abutment = Ht	=	7.30	m					
depth beam	=	1.60	m					
depth slab	=	0.245	m					
depth of beam to deck	=	1.845	m					
depth of beam and deck	=	1.600	+	0.245	=	1.845	m	
depth bearing pad					=	0.100	m	
depth back wall	=	1.845	+	0.100	=	1.945	m	
depth of footing	=	1.000	m					
depth of steam	=	7.300	–	1.945	–	1.000	=	4.355 m

H1	=	1.945	m	W1	=	0.300 m
H2	=	4.355	m	Wf1	=	2.300 m
H3	=	1.000	m	Wf2	=	1.000 m
Ht	=	7.300	m	Wf3	=	1.800 m
	=			W3	=	5.100 m

Depth of back fill	=	7.300	–	1.000	=	6.300 m							
H4	=	0.500	m	W4	=	0.550 m							
H5	=	0.250	m	W5	=	0.550 m							
H6	=	0.500	m	W6	=	0.200 m							
H7	=	0.250	m	W7	=	0.200 m							
H8	=	0.300	m	W8	=	0.300 m							
H9	=	0.300	m	W9	=	1.800 m							

A1	W1	=	0.300	X1 =	W1/2	+	W2	+	Wf3			=	2.950	m
					0.150	+	1.000	+	1.800					
	H1	=	1.945	Y1=	Ht	–	H1/2							
					7.300	–	0.973					=	6.328	m
A2	W2	=	1.000	X2 =	W2/2	+	Wf3							
					0.500	+	1.800					=	2.300	m
	H2	=	4.355	Y2=	H2/2	+	H3							
					2.177	+	1.000					=	3.177	m
A3	W3	=	5.100	X3 =	W3/2									
					2.550							=	2.550	m
	H3	=	1.000	Y3=	H3/2									
					0.500							=	0.500	m
A4	W4	=	0.550	X4 =	W4/2	+	W2	+	Wf3					
					0.275	+	1.000	+	1.800			=	3.075	m
	H4	=	0.500	Y4=	H2	–	H4/2	+	H3					
					4.355	–	0.500	+	1.000			=	4.855	m
A5	W5	=	0.550	X5 =	W5/3	+	W2	+	Wf3					
					0.183	+	1.000	+	1.800			=	2.983	m
	H5	=	0.250	Y5=	H2	–	H4/2	–	H5/3	+	H3			
					4.355	–	0.250	–	0.083	+	1.000	=	5.022	m
A6	W6	=	0.200	X6 =	Wf3	–	W6/2							
					1.800	–	0.100					=	1.700	m
	H6	=	0.500	Y6=	H2	–	H6/2	+	H3					
					4.355	–	0.250	+	0.083			=	4.188	m
A7	W7	=	0.200	X7 =	Wf3	–	W7/3							
					1.800	–	0.067					=	1.733	m
	H7	=	0.250	Y7=	H2	–	H6/2	–	H7/3	+	H3			
					4.355	–	0.250	–	0.083	+	1.000	=	5.022	m
A8	W8	=	2.300	X8 =	W8x2/3	+	Wf2	+	Wf3					
					1.533	+	1.000	+	1.800			=	4.333	m
	H8	=	0.300	Y8=	H8/3	+	H3							
					0.100	+	1.000					=	1.100	m
A9	W9	=	1.800	X9 =	W9x2/3									
					1.200							=	1.200	m
	H9	=	0.300	Y9=	H9/3	+	H3							
					0.100	+	1.000					=	1.100	m

xy

Wing wall

Hgw	=	1.200	m	H back fill	=	6.30	m								
Ww1	=	3.00	m	Hw1	=	3.00	m								
Ww2	=	2.30	m	Hw2	=	1.00	m								
Ww3	=	0.70	m	Hw3	=	1.00	m								
Ww4	=	2.30	m	Hw4	=	2.00	m								
Ww5	=	2.30	m	Hw5	=	0.30	m								

Ww1	Ww1	=	3.000	Xw1=	Ww1/2	+	W2	+	Wf3						
					1.500	+	1.000	+	1.800			=	4.300	m	
	Hw1	=	3.000	Yw1=	Ht	–	Hw1/2								
					7.300	–	1.500					=	5.800	m	
Ww2	Ww2	=	2.300	Xw2=	Ww2/2	+	W2	+	Wf3						
					1.150	+	1.000	+	1.800			=	3.950	m	
	Hw2	=	1.000	Yw2=	Ht	–	Hw1	–	Hw2/2						
					7.300	–	3.000	–	0.500			=	3.800	m	
Ww3	Ww3	=	0.700	Xw3=	W3	–	Ww3/2								
					5.100	–	0.350					=	4.750	m	
	Hw3	=	1.000	Yw3=	Ht	–	Hw1	–	Hw3/2						
					7.300	–	3.000	–	0.333			=	3.967	m	
Ww4	Ww4	=	2.300	Xw4=	Ww4/2	+	W2	+	Wf3						
					1.150	+	1.000	+	1.800			=	3.950	m	
	Hw4	=	2.000	Yw4=	Hw4/2	+	Hw5	+	H3						
					1.000	+	0.300	+	1.000			=	2.300	m	
Ww5	Ww5	=	2.300	Xw5=	W3	–	Ww5x2/3								
					5.100	–	1.533					=	3.567	m	
	Hw5	=	0.300	Yw5=	Hw5/3	+	H3								
					0.100	+	1.000					=	1.100	m	

Guide wall

Gw	Wgw	=	3.000	Xgw=	Wgw/2	+	W2	+	Wf3						
					1.500	+	1.000	+	1.800			=	4.300	m	
	Hgw	=	1.200	Ygw=	Ht	+	Hgw/2								
					7.300	+	0.600					=	7.900	m	

Approach slab

Apr	Wapr	=	3.000	Xapr=	Wapr/2	+	W2	+	Wf3						
					1.500	+	1.000	+	1.800			=	4.300	m	
	Hapr	=	0.200	Yapr=	Ht	–	H1	+	Hapr/2						
					7.300	–	1.945	+	0.100			=	5.455	m	

Asphalt

Ha = 0.05 m

Asp	Wasp	=	3.000	Xasp=	W9/2	+	W2	+	Wf3						
					1.500	+	1.000	+	1.800			=	4.300	m	
	Hasp	=	0.050	Yasp=	Ht	–	Hasp/2								
					7.300	–	0.025					=	7.275	m	

Back fill HWL

a. In case High Water Level

Hwl elvation	=	31.820	m			
Lwl elvation	=	28.020	m	lower than base footing elevation		
Top deck elvation	=	38.700	m			
Base foting elv.	=	38.700	–	7.300	=	31.400 m
Top footing elv.	=	31.400	+	1.000	=	32.400 m
Depth of back fill (H bf)	=	38.700	–	32.400	=	6.300 m

Depth of wet soil

H wet	=	Top deck elv.	–	Hwl elv.--->	Hwl elv. under base footing elv.	
	=	38.700	–	32.400	=	6.300 m
H wet.r	=	Hwc	–	Top footing elv.		
	=	31.020	–	32.400	=	0.000 m
Depth of saturated soil	=	H bf	–	H wet		
H sat	=	6.300	–	6.300	=	0.000 m

xy

a. soil wet condition

wet.l	Wwet.l	=	2.300	X1 =	Wwet.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hwet.l	=	6.300	Y1 =	Ht	−	Hwet.l/2					
					7.300	−	3.150			=	4.150	m
wet.r	Wwet.r	=	1.800	X2 =	Wf3/2							
					0.900					=	0.900	m
	Hwet.r	=	0.000	Y2 =	Hwet.r/2	+	H3					
					0.000	+	1.000			=	1.000	m

b. soil saturated condition

sat.l	Wsat.l	=	2.300	X1 =	Wsat.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hsat.l	=	0.000	Y1 =	Hsat.l/2	+	H3					
					0.000	+	1.000			=	1.000	m
sat.r	Wsat.r	=	1.800	X2 =	Wsat.r/2							
					0.900					=	0.900	m
	Hsat.r	=	0.000	Y2 =	Hsat.r/2	+	H3					
					0.000	+	1.000			=	1.000	m

b. In case Low Water Level

Depth of wet soil on left side footing

H wet.l = Top footing elv. − Hwl elvation

= 38.700 − 32.400 = 6.300 m

Depth of wet soil on right side footing

H wet.r = Hwc elv. − Top footing elv.

= 32.620 − 32.400 = 0.220 m

Depth of saturated soli HWL = Hstr

Hsat = 6.300 − 6.300 = 0.000 m

a. soil wet condition

wet.l	Wwet.l	=	2.300	X1 =	Wwet.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hwet.l	=	6.300	Y1 =	Hwet.l/2	+	H3					
					3.150	+	1.000			=	4.150	m
wet.r	Wwet.r	=	1.800	X2 =	Wwet.r/2							
					0.900					=	0.900	m
	Hwet.r	=	0.220	Y2 =	Hwet.r/2	+	H3					
					0.110	+	1.000			=	1.110	m

b. soil saturated condition

sat.l	Wsat.l	=	2.300	X1 =	Wsat.l/2	+	W2	+	Wf3			
					1.150	+	0.000	+	ERR	=	ERR	m
	Hsat.l	=	0.000	Y1 =	Hsat.l/2	+	H3					
					0.000	+	H3			=	0.000	m
sat.r	Wsat.r	=	1.800	X2 =	Wsat.r/2							
					0.900					=	0.900	m
	Hsat.r	=	0.000	Y2 =	Hsat.r/2	+	H3					
					0.000	+	0.200			=	0.200	m

xy

Project : Medan Flood Control	Japan International	Calculation sheet
Channel : Medan Flood Way	Cooperation Agency	Date
Structure: Br – F3	(JICA)	Nos of sheet
Station : FW 26 + 22		Prepared by

II.2 Axial load to Abutment

a. Superstucture

Vertical load/m'

Length of abutment = 12.00 m

Depth of Abutment = 7.30 m

Width of footing = 5.10 m

Vertical load on abutment :

	Dead load ton	Line load ton	Uniform load ton	Pedestri load ton	=	Total load ton
total	575.08	31.64	264.38	18.60	=	889.70
per Abt.	287.54	15.82	132.19	9.30	=	444.85
per m'	23.96	1.32	11.02	0.78	=	37.07

Siesmic coefficien = 0.15

Horizontal load

Heq = 0.150 x Rdl

= 0.150 x 23.962

= 3.594 ton/m'

Acting point of siesmic load

Wf3 = 1.80 m

H3 = 1.00 m

X = 0.300 + WF3

= 0.300 + 1.80

= 2.100 m

Y = H2 + H3

= 4.355 + 1.00

= 5.355 m

b. Abutment section

Self weight

Sec-tion	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
A1	0.30	1.945	1.00	1.00	2.40	1.400	1.400	2.950	6.328	4.131	4.131
A2	1.00	4.355	1.00	1.00	2.40	10.452	10.452	2.300	3.177	24.040	24.040
A3	5.10	1.00	1.00	1.00	2.40	12.240	12.240	2.550	0.500	31.212	31.212
A4	0.55	0.50	1.00	1.00	2.40	0.660	0.660	3.075	4.855	2.030	2.030
A5	0.55	0.25	1.00	1.00	2.40	0.165	0.165	2.983	5.022	0.492	0.492
A6	0.20	0.50	1.00	1.00	2.40	0.240	0.240	1.700	4.188	0.408	0.408
A7	0.20	0.50	1.00	1.00	2.40	0.120	0.120	1.733	5.022	0.208	0.208
A8	2.30	0.30	1.00	1.00	2.40	0.828	0.828	4.333	1.100	3.588	3.588
A9	1.80	0.30	1.00	1.00	2.40	0.648	0.648	1.200	1.100	0.778	0.778
					sum		26.75			66.89	66.89

Wing wall and guard wall

Ww1	3.000	3.000	0.40	2.00	2.400	1.440	0.120	4.300	5.800	0.516	0.516
Ww2	2.300	1.000	0.40	2.00	2.400	0.368	0.031	3.950	3.500	0.121	0.107
Ww3	0.400	1.000	0.40	2.00	2.400	0.064	0.005	5.333	3.967	0.028	0.021
Ww4	2.300	2.000	0.40	2.00	2.400	0.736	0.061	3.950	2.300	0.242	0.141
Ww5	2.300	0.300	0.40	2.00	2.400	0.110	0.009	0.533	1.100	0.005	0.010
Gw	3.000	1.20	0.40	2.00	2.000	0.480	0.040	4.300	7.900	0.172	0.316
					sum		0.227			0.913	0.796

Miscellaneous load

Aproaach Road,Guide wall and Asphalt

Aps	3.00	0.20	1.00	1.00	2.400	1.44	1.440	4.300	5.455	6.192	7.855
asp	3.00	0.05	1.00	1.00	2.300	0.35	0.345	4.300	7.275	1.483	2.510
					sum		1.785			7.675	10.365
					total		28.765			75.47	78.05

axl-lod

Centre of gravity

$X = \frac{Gv/m'.X}{Gv/m'}$	$Y = \frac{Gv/m'.Y}{Gv/m'}$
$= \frac{75.474}{28.765} = 2.624$ m	$= \frac{78.047}{28.765} = 2.713$ m

H-filling = 0.150 x 28.765 = 4.315 ton

c. Back fill

a. Incase High Water level

Depth of back fill = 6.300 m
H wet.l = 6.300 m
H wet.r = 4.355 m
H saturated = 0.000 m

Section	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	6.300	1.00	1.00	1.850	26.807	26.807	3.950	4.150	105.89	111.25
Wet.r	1.800	4.355	1.00	1.00	1.850	14.502	14.502	0.900	1.100	13.05	15.95
Sat.l	2.300	0.000	1.00	1.00	2.000	0.000	0.000	3.950	1.000	0.000	0.000
Sat.r	1.800	0.000	1.00	1.00	2.000	0.000	0.000	0.900	1.000	0.000	0.000
					sum		41.309			118.938	127.199

$X = \frac{Gv/m'.X}{Gv/m'}$	$Y = \frac{Gv/m'.Y}{Gv/m'}$
$= \frac{118.938}{41.309} = 2.879$ m	$= \frac{127.199}{41.309} = 3.079$ m

H-filling = 0.150 x 41.309 = 6.196 ton

b. Low water level

Depth of Hwet.l = 6.300 m
Depth of Hwet.r = 4.355 m
Depth of H saturated = 0.000 m

a. Wet condition

Section	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	6.300	1.00	1.00	1.850	26.807	26.807	3.950	4.150	105.886	111.247
Wet.r	1.800	4.355	1.00	1.00	1.850	14.502	14.502	0.900	0.091	13.052	1.318
Sat.l	2.300	0.000	1.00	1.00	2.000	0.000	0.000	3.950	0.000	0.000	0.000
Sat.r	1.800	0.000	1.00	1.00	2.000	0.000	0.000	0.900	0.000	0.000	0.000
					sum		41.309			118.938	112.565

Habt 0.150 x 41.309 = 6.196 ton

Centre of gravity

$X = \frac{Gv/m'.X}{Gv/m'}$	$Y = \frac{Gv/m'.Y}{Gv/m'}$
$= \frac{118.938}{41.309} = 2.879$ m	$= \frac{112.565}{41.309} = 2.725$ m

axl-lod

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F 3 Station : Fw 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II.3 Lateral earth pressure due to earthquake

Kh = C x I x S

Kh = coefficient of horizontal siesmic loading

C = the base shear coefficient,base on the data :
siesmic zone and soil condition

Siesmic zone = 4

soil condition soft soil C = 0.15

S = the structure type factor = 1

I = the importance factor

for bridge carrying more than
2.000 vehicle per day

I = 1.2

C	I	S	kh
0.15	1.2	1	0.18

for all other permanent bridge

I = 1

C	I	S	kh
0.15	1	1	0.15

for temporary bridge

I = 0.8

C	I	S	kh
0.15	0.8	1	0.12

soil condition firm soil C = 0.10

for bridge carrying more than
2.000 vehicle per day

C	I	S	kh
0.1	1.2	1	0.12

for all other permanent bridge

C	I	S	kh
0.1	1.00	1	0.10

for temporary bridge

C	I	S	kh
0.1	0.8	1	0.08

source,Bridge Management System

eq

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel : Medan Flood Way		Date	
Structure : Br – F 3		Nos of sheet	
Station : Fw 28 + 22		Prepared by	

II.4 Columb's coefficient

Right side Abutment

Normal condition

ø	=	30.00	deg.	ø – alpa	=	30.00	–	0.0	= 30.00	deg.
alpa	=	0.0	deg.	ø + delta	=	30.00	+	30.00	= 60.00	deg.
Q	=	0.0	deg.	ø – beta	=	30.00	–	0.0	= 30.00	deg.
delta	=	30.00	deg.	alpa + delta	=	0.0	+	30.00	= 30.00	deg.
beta	=	0.0	deg.	alpa – beta	=	0.0	–	0.000	= 0.00	deg.

$$Ka = \frac{\text{Cos}^2(ø - \text{alpa})}{\text{Cos}^2\,\text{alpa}.\cos(\text{alpa} + \text{delta}).\left\{\left(1 + \sqrt{\frac{\sin(ø + \text{delta}).(\sin(Ø - \text{beta})}{\cos(\text{alpa} + \text{delta}).\cos(\text{alpa} - \text{beta})}}\right)\right\}^2}$$

Cos(alpa)	=	1.000	sin(ø + delta)	=	0.866
Cos^2 (alpa)	=	1.000	sin(ø – beta)	=	0.500
Cos(ø – alpa)	=	0.866	cos(alpa + delta)	=	0.866
Cos^2 (ø – alpa)	=	0.750	cos(alpa – beta)	=	1.000

A = sin(ø+delta).sin(ø–beta)
= 0.866 x 0.500
= 0.433

B = cos (alpa + delta).cos(alpa–beta)
= 0.866 + 1.000
= 0.866

C = cos^2 (alpa).cos(alpa+delta)
= 1.000 x 0.866
= 0.866

@sqrt(A/I = 0.71

D = (1 + @sqrt(A/B) ^2
= (1.000 + 0.707) ^2
= 2.914

C.D = 0.866 x 2.914
= 2.524

$$Ka = \frac{\text{Cos}^2(ø - \text{alpa})}{\text{C.D}} = \frac{0.75}{2.52} = 0.297$$

Earth quake condition

$$Ke = \frac{\text{Cos}(ø - \text{alpa} - Qo)^2}{\text{Cos}\,Qo.\text{Cos}^2\,\text{alpa}.\cos(\text{alpa} + \text{delta}^\wedge + Qo).\left\{\left(1 + \sqrt{\frac{\sin(ø + \text{delta}).(\sin(Ø - \text{beta} - Qo)}{\cos(\text{alpa} + \text{delta} + Qo).\cos(\text{alpa} - \text{beta})}}\right)\right\}^2}$$

Qo = composite siesmic angle

$$k' = \tan^{-1}.k = \frac{Y}{Y-1} \times k$$

k = siesmic coefficient in air
= 0.15

Y = 2.00

Y – 1 = 1.00

colum

$$k' = \frac{Y}{Y-1} \times k = \frac{2.00}{1.00} \times 0.15 = 0.30$$

Qo = @atan^–1.k
Qo = 8.5308

ø	=	30.00	deg.	ø – alpa–Qo	=	30.00	–	0.00	– 8.53	= 21.47
alpa	=	0.00	deg.	ø + delta	=	30.00	+	15.00		= 45.00
Q	=	8.53	deg.	ø – beta–Qo	=	30.00	–	0.00	– 8.53	= 21.47
delta	=	15.00	deg.	ø – beta + Qo	=	30.00	–	0.00	+ 8.53	= 38.53
beta	=	0.00	deg.	alpa + delta+Qo	=	0.00	+	15.00	+ 8.53	= 23.53
				alpa – beta	=	0.000	–	0.000		= 0.00

Cos(Qo)	=	0.989			
Cos(alpa)	=	1.000	sin(ø + delta)	=	0.707
Cos^2 (alpa)	=	1.000	sin(ø – beta – (	=	0.366
Cos(ø – alpa – Qo)	=	0.931	cos(alpa + delta	=	0.917
Cos^2 (ø – alpa–Qo) ^2	=	0.866	cos(alpa – beta)	=	1.000

A = sin(ø+delta).sin(ø–beta–Qo)
= 0.707 x 0.366
= 0.259

B = cos (alpa + delta+Qo).cos(alpa–beta)
= 0.917 + 1.000
= 0.917

C = cos Qo.Cos^2(alpa).cos(alpa+delta+Qo)
= 0.989 x 1.000 x 0.92
= 0.907

@sqrt(A/B) = 0.531

D = (1 + @sqrt(A/B) ^2
= (1.000 + 0.531) ^2
= 2.345

C.D = 0.907 x 2.345
= 2.126

$$Ke = \frac{\text{Cos}^2(ø - \text{alpa})}{\text{C.D}} = \frac{0.87}{2.126} = 0.407$$

colum

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
Structure	: Br – F3		Nos of sheet
Station	: FW 28 + 22		Prepared by

II.6 Combined load

II.6.1 Case – I, Normal condition

High Water Level

Length	L	=	12.00	m
Width of floting	W3	=	5.10	m
Thick of footing	H3	=	1.00	m

	Item	V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
	Super structure V–sp	37.070		2.100		77.847	
	Abutment V–abt	28.765		2.624		75.479	
	Back fill V–bf	41.309		2.879		118.929	
	Active earth pressure						
	Surcharge load Pq		1.871		3.900		7.297
Wet soil	triangle load Pw		13.004		2.293		29.818
Sat.soil	rectangular load Ps1						
	triangle load Ps2						
	Water Pw						
	Up life Pu						
	Total	107.144	14.875			272.255	37.115

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{272.255}{107.144} = 2.541 \text{ m}$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{37.115}{14.875} = 2.495 \text{ m}$$

V = V/m' x L
= 107.14 x 12.00
= 1,285.73 ton

H = H/m' x L
= 14.88 x 12.00
= 178.50 ton

M = V.(X–(0.5.W)) – H.(Y–tb)

0.5 x W = 0.50 x 5.10
= 2.55 m

(X – (0.5xW)) = 2.54 – 2.55
= (0.01) m

(Y – tb) = 2.495 – 1.00
= 1.50 m

H x (Y – tb) = 178.50 x 1.50
= 266.88 t.m

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 1,285.73 x (0.01) – 266.88
= (11.55) – 266.88
= (278.43) t.m

cld–an

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel	: Medan Flood Way		Date
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II.5 Horizontal force at Abutment

II.5.1 Case – I, Normal Condition

Depth of abutment	=	7.30	m	
Surcharge load	=	1.00	t/m2	
Unit weight wet soil	=	1.85	t/m3	
Unit weight saturated soil	=	2.00	t/m3	
Unit weight of water	=	1.00	t/m3	
Width of footing				
Wf1	=	2.30	m	
Wf2	=	1.00	m	
Wf3	=	1.80	m	
W3	=	5.10	m	
Elevation of Lwl	=	28.020	m	
Elevation of Hwl	=	31.820	m	
Top slab elevation	=	38.700	m	
Depth of footing	=	1.000	m	
Elv.of base footing	=	38.700 –	7.30 =	31.400 m
Elv.of top footing	=	31.400 +	1.00 =	32.400 m
Depth of back fill	=	38.700 –	32.400 =	6.300 m

Depth of wet soil = H wet
H wet = Top elv. – Hwl elv.
H wet = 38.700 – 31.820 = 6.880 m

Depth of saturated soil = H sat
H sat = 6.30 – 6.880 = 0.000 m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000
delta	=	0.000	L	=	1.000 m
alpa	=	0.000	H	=	6.300 m
Cos(alpha	=	1.000	B	=	5.100 m

oefficient of active pressure Ka = 0.297

Pq = q x H x L x Ka
Pq = 1.000 x 6.300 x 1.000 x 0.297
Pq = 1.871 ton

Pqv	=	Hq	x Sin(alpha)	Pqh	=	Hq	x Cos(alpha)
	=	1.871	x 0.000		=	1.871	x 1.000
	=	0.000 ton			=	1.871 ton	
X	=	5.100 m		Y	=	6.300 :	2.000
					=	3.150 m	

B By earth

B–1 Wet soil

Length = 1.000 m
Hwet = 6.880 m
Hsat = 0.000 m

fh–1

1. Load triangular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x	Ka
	=	0.500	x	1.850	x	47.334	x	1.000	x	0.297
	=	13.004 ton								

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)	
	=	13.004	x	0.000		=	13.004	x	1.000	
	=	0.000 ton				=	13.004 ton			
X	=	5.100 m			Y	=	6.880	:	3.000	+ 0.000
						=	2.293 m			

B−2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L	x Ka
	=	2.000	x	0.000	x	1.000	x 0.297
	=	0.000 ton					

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x	Cos(alpha)	
	=	0.000		0.000		=	0.000	x	1.000	
	=	0.000 ton				=	0.000 ton			
X	=	5.100 m			Y	=	0.000	:	2.000	
						=	0.000 m			

3. Load triangular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x	Ka
	=	0.500	x	2.000	x	0.000	x	1.000	x	0.297
	=	0.000 ton								

Ps2(v)	=	H sat−2	x	Sin(alpha)	Ps2(h)	=	H sat−2	x	Cos(alpha)	
	=	0.000	x	0.000		=	0.000	x	1.000	
	=	0.000 ton				=	0.000 ton			
X	=	5.100 m			Y	=	0.000	:	3.000	
						=	0.000 m			

4. Water

Hw = 0.000 m

Pw	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000 ton						
X	=	5.100 m						
Y	=	0.000	:	3.000				
	=	0.000 m						

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100	:	2.000		
	=	2.550 m				

Project : Medan Flood Control	Japan International	Calculation sheet
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II.5.2 Case − II, Normal Condition
Low Water Level

Depth of abutment	=	7.30 m				
Surcharge load	=	1.00 t/m2				
Unit weight wet soil	=	1.85 t/m3				
Unit weight saturated soil	=	2.00 t/m3				
Unit weight of water	=	1.00 t/m3				
Width of footing						
Wf1	=	2.30 m				
Wf2	=	1.00 m				
Wf3	=	1.80 m				
W3	=	5.10 m				
Elevation of Lwl	=	28.020 m				
Elevation of Hwl	=	31.820 m				
Top slab elevation	=	38.700 m				
Depth of footing	=	1.000 m				
Elv.of base footing	=	38.700	−	7.30	=	31.400 m
Elv.of top footing	=	31.400	+	1.00	=	32.400 m
Depth of back fill	=	38.700	−	32.400	=	6.300 m

Depth of wet soil = H wet

H wet	= Top elv.	−	Hwl elv.			
H wet	= 38.700	−	32.400	=	6.300	m
Depth of saturated soil	= H sat					
H sat	= 6.30	−	6.300	=	0.000	m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	6.300	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ka = 0.297

Pq	=	q	x	H	x	L	x Ka
Pq	=	1.000	x	6.300	x	1.000	x 0.297
Pq	=	1.871 ton					

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x	Cos(alpha)	
	=	1.871	x	0.000		=	1.871	x	1.000	
	=	0.000 ton				=	1.871 ton			
X	=	5.100 m			Y	=	6.300	:	2.000	
						=	3.150 m			

B By earth

B−1 Wet soil

Length	=	1.000 m
Hwet	=	6.300 m
Hsat	=	0.000 m

1. Load trianngular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x Ka
	=	0.500	x	1.850	x	39.690	x	1.000	x 0.297
	=	10.904 ton							

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x Cos(alpha)
	=	10.904	x	0.000		=	10.904	x 1.000
	=	0.000 ton				=	10.904 ton	
X	=	5.100 m			Y	=	6.300 : 3.000 + 0.000	
						=	2.100 m	

B-2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L x Ka
	=	2.000	x	0.000	x	1.000 x 0.297
	=	0.000 ton				

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x Cos(alpha)
	=	0.000		0.000		=	0.000	x 1.000
	=	0.000 ton				=	0.000 ton	
X	=	5.100 m			Y	=	0.000 : 2.000	
						=	0.000 m	

3. Load trianngular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x Ka
	=	0.500	x	2.000	x	0.000	x	1.000	x 0.297
	=	0.000 ton							

Ps2(v)	=	H sat-2	x	Sin(alpha)	Ps2(h)	=	H sat-2	x Cos(alpha)
	=	0.000	x	0.000		=	0.000	x 1.000
	=	0.000 ton				=	0.000 ton	
X	=	5.100 m			Y	=	0.000 : 3.000	
						=	0.000 m	

4. Water

Hw = 0.000 m

Pw	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000 ton						
X	=	5.100 m						
Y	=	0.000 : 3.000						
	=	0.000 m						

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100 : 2.000				
	=	2.550 m				

fh-2

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br - F3 Station : Fw 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II.5.3 Case - III, Earthquake Condition

High Water Level

Depth of abutment	=	7.30 m			
Surcharge load	=	0.50 t/m2			
Unit weight wet soil	=	1.85 t/m3			
Unit weight saturated soil	=	2.00 t/m3			
Unit weight of water	=	1.00 t/m3			
Width of footing					
Wf1	=	2.30 m			
Wf2	=	1.00 m			
Wf3	=	1.80 m			
W3	=	5.10 m			
Elevation of Lwl	=	28.020 m			
Elevation of Hwl	=	31.820 m			
Top slab elevation	=	38.700 m			
Depth of footing	=	1.000 m			
Elv.of base footing	=	38.700 -	7.30	=	31.400 m
Elv.of top footing	=	31.400 +	1.00	=	32.400 m
Depth of back fill	=	38.700 -	32.400	=	6.300 m

Depth of wet soil = H wet

H wet = Top elv. - Hwl elv.

H wet = 38.700 - 31.820 = 6.880 m

Depth of saturated soil = H sat

H sat = 6.30 - 6.880 = 0.000 m

A Active earth pressure

By live load

Surcharge load = (q)

q	=	0.500 t/m2		Sin(alpha)	=	0.000
delta	=	0.000		L	=	1.000 m
alpa	=	0.000		H	=	6.300 m
Cos(alpha	=	1.000		B	=	5.100 m

oefficient of active pressure Ke = 0.407

Pq	=	q	x	H	x	L	x	Ke
Pq	=	0.500	x	6.300	x	1.000	x	0.407
Pq	=	1.282 ton						

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x Cos(alpha)
	=	1.282	x	0.000		=	1.282	x 1.000
	=	0.000 ton				=	1.282 ton	
X	=	5.100 m			Y	=	6.300 : 2.000	
						=	3.150 m	

B By earth

B-1 Wet soil

Length = 1.000 m

Hwet = 6.880 m

Hsat = 0.000 m

fh-3

1. Load trianngular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x	Ke
	=	0.500	x	1.850	x	47.334	x	1.000	x	0.407
	=	17.820 ton								

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)	
	=	17.820	x	0.000		=	17.820	x	1.000	
	=	0.000 ton				=	17.820 ton			
X	=	5.100 m			Y	=	6.880	:	3.000	+ 0.000
						=	2.293 m			

B-2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L	x Ke
	=	2.000	x	0.000	x	1.000	x 0.407
	=	0.000 ton					

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x	Cos(alpha)	
	=	0.000		0.000		=	0.000	x	1.000	
	=	0.000 ton				=	0.000 ton			
X	=	5.100 m			Y	=	0.000	:	2.000	
						=	0.000 m			

3. Load trianngular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x	Ke
	=	0.500	x	2.000	x	0.000	x	1.000	x	0.407
	=	0.000 ton								

Ps2(v)	=	H sat-2	x	Sin(alpha)	Ps2(h)	=	H sat-2	x	Cos(alpha)	
	=	0.000	x	0.000		=	0.000	x	1.000	
	=	0.000 ton				=	0.000 ton			
X	=	5.100 m			Y	=	0.000	:	3.000	
						=	0.000 m			

4. Water

Hw = 0.000 m

Pw	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000 ton						
X	=	5.100 m						
Y	=	0.000	:	3.000				
	=	0.000 m						

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100	:	2.000		
	=	2.550 m				

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II.5.4 Earthquake Condition

Low Water Level

Depth of abutment	=	7.30 m
Surcharge load	=	0.50 t/m2
Unit weight wet soil	=	1.85 t/m3
Unit weight saturated soil	=	2.00 t/m3
Unit weight of water	=	1.00 t/m3
Width of footing		
Wf1	=	2.30 m
Wf2	=	1.00 m
Wf3	=	1.80 m
W3	=	5.10 m
Elevation of Lwl	=	28.020 m
Elevation of Hwl	=	31.820 m
Top slab elevation	=	38.700 m
Depth of footing	=	1.000 m
Elv.of base footing	=	38.700 - 7.30 = 31.400 m
Elv.of top footing	=	31.400 + 1.00 = 32.400 m
Depth of back fill	=	38.700 - 32.400 = 6.300 m

Depth of wet soil = H wet

H wet = Top elv. - Hwl elv.

H wet = 38.700 - 32.400 = 6.300 m

Depth of saturated soil = H sat

H sat' = 6.30 - 6.300 = 0.000 m

A Active earth pressure

By live load

Surcharge load = (q)

q	=	0.500 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	6.300	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ke = 0.407

Pq	=	q	x	H	x	L	x Ke
Pq	=	0.500	x	6.300	x	1.000	x 0.407
Pq	=	1.282 ton					

Pqv	=	Hq	x	Sin(alpha)	Pqh	=	Hq	x	Cos(alpha)	
	=	1.282	x	0.000		=	1.282	x	1.000	
	=	0.000 ton				=	1.282 ton			
X	=	5.100 m			Y	=	6.300	:	2.000	
						=	3.150 m			

B By earth

B-1 Wet soil

Length = 1.000 m

Hwet = 6.300 m

Hsat = 0.000 m

1. Load trianngular

Pw	=	0.500	x	Ywet	x	Hwet^2	x	L	x	Ke
	=	0.500	x	1.850	x	39.690	x	1.000	x	0.407
	=	14.942 ton								

Pw(v)	=	Pw	x	Sin(alpha)	Pw(h)	=	Pw	x	Cos(alpha)
	=	14.942	x	0.000		=	14.942	x	1.000
	=	0.000 ton				=	14.942 ton		
X	=	5.100 m			Y	=	6.300	:	3.000 + 0.000
						=	2.100 m		

B-2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1	=	Ysat	x	H sat	x	L	x Ke
	=	2.000	x	0.000	x	1.000	x 0.407
	=	0.000 ton					

Ps1(v)	=	H sat	x	Sin(alpha)	Ps1(h)	=	H sat	x Cos(alpha)
	=	0.000		0.000		=	0.000	x 1.000
	=	0.000 ton				=	0.000 ton	
X	=	5.100 m			Y	=	0.000	: 2.000
						=	0.000 m	

3. Load trianngular

Ps2	=	0.500	x	Ysat	x	H sat^2	x	L	x Ke
	=	0.500	x	2.000	x	0.000	x	1.000	x 0.407
	=	0.000 ton							

Ps2(v)	=	H sat-2	x	Sin(alpha)	Ps2(h)	=	H sat-2	x Cos(alpha)
	=	0.000	x	0.000		=	0.000	x 1.000
	=	0.000 ton				=	0.000 ton	
X	=	5.100 m			Y	=	0.000	: 3.000
						=	0.000 m	

4. Water

Hw = 0.000 m

Pw	=	0.500	x	Yw	x	Hw^2	x	L
	=	0.500	x	1.000	x	0.000	x	1.000
	=	0.000 ton						
X	=	5.100 m						
Y	=	0.000	:	3.000				
	=	0.000 m						

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x	Yw
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100	:	2.000		
	=	2.550 m				

fh-4

II.6.1 Case - II, Normal condition
Low Water Level

	Item	Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
Super structure	V-sp	37.070		2.100		77.847	
Abutment	V-Abt	28.765		2.624		75.479	
Back fill	V-bf	41.309		2.879		118.929	
				Active earth pressure			
Surcharge load	Hq		1.871		3.150		5.894
Wet soil triangle load	Hwet		10.904		2.100		22.898
Sat.soil rectangular load	Hsat-1						
triangle load	Hsat-2						
Water	Pw						
Up life	Pu						
Total		107.144	12.775			272.255	28.792

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{272.255}{107.144} = 2.541\ m$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{28.792}{12.775} = 2.254\ m$$

V = V/m' x L
= 107.14 x 12.00
= 1,285.73 ton

H = H/m' x L
= 12.78 x 12.00
= 153.30 ton

M = V x (X-(0.5 x W)) - (H x (Y-tb))

0.5 x W = 0.500 x 5.10
= 2.55 m

(X-(0.5xW)) = 2.541 - 2.55
= (0.01) m

(Y - tb) = 2.254 - 1.00
= 1.25 m

H x (Y - tb) = 153.30 x 1.25
= 192.20 m

= V x (X-(0.5 x W)) - (H x (Y-tb))
= 1,285.73 x (0.01) - 192.20
= (11.55) - 192.20
= (203.75) t.m

cld-an

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II.6 Combined load

II.6.3 Case – III, Earthquake condition High Water Level

Length	L	=	12.00	m	
Width of floting	W3	=	5.10	m	
Thick of footing	H3	=	1.00	m	

	Item		V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
	Super structure	V-sp	32.070	3.398	2.100	5.355	67.347	18.196
	Abutment	V-abt	28.765	4.315	2.624	2.713	75.479	11.707
	Back fill	V-bf	41.309	6.196	3.079	2.735	127.190	16.946
			Active earth pressure					
	Surcharge load	Pq		1.282		3.150		4.038
Wet soil	triangle load	Pw		17.820		2.293		40.861
Sat.soil	rectangular load	Ps1						
	triangle load	Ps2						
	Water	Pw						
	Up life	Pu						
	Total		102.144	33.011			270.017	91.749

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{270.017}{102.144} = 2.643\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{91.749}{33.011} = 2.779\ m$$

V = V/m' x L
= 102.14 x 12.00
= 1,225.73 ton

H = H/m' x L
= 33.01 x 12.00
= 396.13 ton

M = V.(X-(0.5.W)) – H.(Y-tb)

0.5 x W	= 0.50 x	5.10	
	= 2.55 m		
(X-(0.5xW))	= 2.64 –	2.55	
	= 0.09 m		
(Y – tb)	= 2.779 –	1.00	
	= 1.78 m		
H x (Y – tb)	= 396.13 x	1.78	
	= 704.85 t.m		

= V x (X-(0.5 x W)) – (H x (Y-tb))
= 1,225.73 x 0.09 – 704.85
= 114.59 – 704.85
= (590.26) t.m

cld-aq

II.6.4 Case – IV, Earthquake condition Low Water Level

	Item		Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
	Super structure	V-sp	32.070	3.398	2.100	5.355	67.347	18.196
	Abutment	V-Abt	28.765	4.315	2.624	2.713	75.479	11.707
	Back fill	V-bf	41.309	6.196	2.979	2.725	123.060	16.884
					Active earth pressure			
	Surcharge load	Hq		2.282		3.150		7.188
Wet soil	triangle load	Hwet		14.942		2.100		31.378
Sat.soil	rectangular load	Hsat-1						
	triangle load	Hsat-2						
	Water	Pw						
	Up life	Pu						
	Total		102.144	31.133			265.886	85.353

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{265.886}{102.144} = 2.603\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{85.353}{31.133} = 2.742\ m$$

V = V/m' x L
= 102.14 x 12.00
= 1,225.73 ton

H = H/m' x L
= 31.13 x 12.00
= 373.60 ton

M = V x (X-(0.5 x W)) – (H x (Y-tb))

0.5 x W	= 0.500 x	5.10	
	= 2.55 m		
(X-(0.5xW))	= 2.603 –	2.55	
	= 0.05 m		
(Y – tb)	= 2.742 –	1.00	
	= 1.74 m		
H x (Y – tb)	= 373.60 x	1.74	
	= 650.65 m		

= V x (X-(0.5 x W)) – (H x (Y-tb))
= 1,225.73 x 0.05 – 650.65
= 65.02 – 650.65
= (585.62) t.m

cld-aq

PRESTRESSED CONCRETE BRIDGE COMPUTATION
CHANNEL MEDAN FLOOD WAY
Br – Mf 3
Station : Fw 22 + 28

span
31.00

III FOUNDATION

Pile for Abutment

- III.1 Charateristic of pile
  - III.1.1 Normal condition
  - III.1.2 Earthquake condition
- III.2 Axial bearing load allowance for a pile
- III.3 Spring constant of a pile
  - III.3.1 Normal condition
  - III.3.2 Earthquake condition
- III.4 Displacement of a head pile
  - III.4.1 Normal condition
  - III.4.2 Earthquake condition
- III.5 Coeficient displacement of footing
  - III.5.1 Case – I,Normal condition (HWL)
  - III.5.2 Case – II,Normal condition (LWL)
  - III.5.3 Case – III,Earthquake condition (HWL)
  - III.5.4 Case – IV,Earthquake condition (LWL)
- III.6 Forces at the i–th pile head
  - III.6.1 Case – I,Normal condition (HWL)
  - III.6.2 Case – II,Normal condition (LWL)
  - III.6.3 Case – III,Earthquake condition (HWL)
  - III.6.4 Case – IV,Earthquake condition (LWL)
- III.7 Control stresses on a head pile
  - III.7.1 Normal condition
  - III.7.2 Earthquake condition
- III.8 Combined load at Abutment section
  - III.8.1 Case – I,Normal condition (HWL)
  - III.8.2 Case – II,Normal condition (LWL)
  - III.8.3 Case – III,Earthquake condition (HWL)
  - III.8.4 Case – IV,Earthquake condition (LWL)
- III.9 Resume Load on Abutment Section
- III.10 Reinforcing steel bar

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III. FOUNDATION

III.1 Charateristic Value of Pile

III.1.1 Normal Condition

Beta = charateristic value of pile
kh = coeficient of horizontal subgrade reaction (kr/cm^3)
EI = flexural rigidity of pile
do = outer diameter of pile (cm)
Eo = modulus of deformation of the ground ontained from table

do	=	40.00 cm		
t	=	7.500 cm		
do^2	=	1,600 cm^2		
di	=	(do–2.t)		
	=	40 –	15	
	=	25 cm		
di^2	=	625 cm^2		
do^2–di^2	=	1,600 –	625	
	=	975 cm		
do^4	=	2,560,000 cm4		
di^4	=	390,625 cm4		
do^4– di^4	=	2,560,000 –	390,625	
	=	2,169,375 cm4		

Modulus elasticity

a. concrete
Permanent load K – 400

Ec = 343,327 kg/cm2

b. steel

Es = 1,897,200 kg/cm2

Inertia of pile, concrete K – 400

Ix = @pi/64(do^4–di^4)
= 0.05 x 2,169,375
= 106,489 cm^4

Area of prestress

Ap = @pi/4 (do^2 – di^2)
= 0.79 x 975.00
= 765.76 cm^2

$$Beta = \left(\frac{kh.do}{4.E.I}\right)^{0.25}$$

kho = 1/30 x alpa x Eo
Alpha = 0.20 from table 3.5
Eo = 28 x N
= 28.00 x 10.00
= 280 kg/cm3

E.I = 343,327 x 106,489 = 3.66E+10 kg.cm2
4.E.I = 4 x 3.66E+10 = 1.46E+11 kg.cm2

kho = 1/30 x Alpa x Eo
= 0.03 x 1 x 280
= 9.33 kg/cm3

charc–n

4 - 276

$$kh = kho \times \{(Beta\ h)/30\}^{-0.75} \quad (1)\text{--------equition}$$

Beta h = Bh
Beta = B
Bh = @sqrt(do / B)
do = 40.00
----- = ---------- = 6,802.27
B = 0.00588039 ---> B find by trial
Bh = 82.48
82.48
(Bh / 30) = ---------- = 2.75
30.00
(Bh/30) ^ –0.75 = 0.47
kh = 9.33 x 0.47
= 4.3715

$$B = \left(\frac{kh \times do}{4.EI}\right)^{0.25} \quad (2)\text{--------equition}$$

$$kh = \frac{Beta^4 \times 4.EI}{do}$$

$$kh = \frac{1.20E-09}{40.00} \times 1.46E+11$$

------ (1) = ------ (2)

4.3715 = 4.3716 kg/cm3

By trial value of " kh " left side = right side

kh = 4.3716 kg/cm3
= 4,371.57 tom/m3
B = 0.00588 cm–1
B = 0.588039 m^-1
kh x do = 4.3716 x 40.00
= 174.86

Allowance Horizontal Force

Normal Condition

$$Han = \frac{kh \times do}{B} \times delta$$

$$= \frac{174.86}{0.01} \times 1.00$$

= 29,736.57 kg

= 29.74 ton

charc–n

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III.1.2 Earthquake Condition (LWL)

Beta	=	charateristic value of pile
kh	=	coeficient of horizontal subgrade reaction (kr/cm^3)
EI	=	flexural rigidity of pile
do	=	outer diameter of pile (cm)
Eo	=	modulus of deformation of the ground ontained from table

do	=	40.0	cm	
t	=	7.50	cm	
do^2	=	1,600	cm^2	
di	=	(do–2.t)		
	=	40 –	15	
	=	25	cm	
di^2	=	625	cm^2	
do^2–di^2	=	1,600 –	625	
	=	975	cm	
do^4	=	2,560,000	cm4	
di^4	=	390,625	cm4	
do^4– di^4	=	2,560,000 –	390,625	
	=	2,169,375	cm4	

Modulus elasticity

a. concrete

Permanent load K – 400

Ec = 514,991 kg/cm2

b. steel

Es = 1,897,200 kg/cm2

Inertia of pile,concrete K.400

Ix = @pi/64(do^4–di^4)

= 0.05 x 2,169,375

= 106,489 cm^4

Area of prestress

Ap = @pi/4 (do^2 – di^2)

= 0.79 x 975.00

= 765.76 cm^2

$$Beta = \left(\frac{kh.do}{4.E.I}\right)^{0.25}$$

kho = 1/30 x alpa x Eo

Alpha = 0.20 from table 3.5

Eo = 28 x N

= 28.00 x 10.00

= 280 kg/cm3

E.I = 514,991 x 106,489 = 5.48E+10 kg.cm2

4.E.I = 4 x 5.48E+10 = 2.19E+11 kg.cm2

kho = 1/30 x Alpa x Eo

= 0.03 x 1 x 280

= 9.33 kg/cm3

charc–q

$$kh = kho \times \{(Beta\ h)/30\}^{-0.75} \quad (1)\text{--------equition}$$

Beta h = Bh

Beta = B

Bh = @sqrt(do / B)

do = 40.00

$\frac{do}{B} = \frac{40.00}{0.00526039} = 7{,}604.00$ ---> B find by trial

Bh = 87.20

87.20

$(Bh / 30) = \frac{87.20}{30.00} = 2.91$

$(Bh/30)^{-0.75} = 0.45$

kh = 9.33 x 0.45

= 4.1926

$$B = \left(\frac{kh \times do}{4.EI}\right)^{0.25} \quad (2)\text{--------equition}$$

$$kh = \frac{Beta^4 \times 4.EI}{do}$$

$$kh = \frac{7.66E-10}{40.00} \times 2.19E+11$$

(1) = (2)

4.1926	=	4.1993 kg/cm3

By trial value of " kh " left side = right side

kh	=	4.1993	kg/cm3
	=	4,199.29	tom/m3
B	=	0.00526	cm–1
B	=	0.526039	m–1
kh x do	=	4.1993 x	40.00
	=	167.97	

Allowance Horizontal Force

Earthquake Condition

$$Haq = \frac{kh \times do}{B} \times delta$$

$$= \frac{167.97}{0.01} \times 1.00$$

= 31,931.40 kg

= 31.931 ton

charc–q

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F3 Station : FW 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by	

III.2 Axial bearing load allowance for a pile

a. by soil

do = outer diameter of a pile (m)
di = inner diameter of a pile (m)
Lb = depth of log boring from top soil to the hard layer N > 40
As = total circumferential surface area of the pile (m2)
N2' = mean N–value in the range from the tip of the pile to 10xD above.
do = diameter or width of the pile
Ru = ultimate bearing capacity of the pile
li = statum thickness with the skin friction power taken into account (m)
fi = maximum unit area skin friction power of statum with the skin friction power taken into account (t/m2)
Ws = effective weight of soil which replace by pile
W = effective weight of concrete which filled in the pile
Lc = length of pile filled by concrete
N2' = Mean N–value in the range from the tip of the pile to 10xD above.
do = diameter or width of the pile

do	=	0.40	m			
t	=	0.075	m			
di	=	(do – (2 x t)		m		
	=	0.40	–	0.150		
	=	0.25	m			
do^2	=	0.1600	m2			
di^2	=	0.0625	m2			
do^2–di^2	=	0.1600	–	0.06		
	=	0.0975	m2			
Ap	=	area of a pile (m2)				
	=	0.25	x	3.14	x(do^2	– di^2)
	=	0.25	x	3.14	x 0.0975	
	=	0.0766	m2			
Length of pile	=	Lp				
Lp	=	9.00	m			
ro	=	0.20	m			
U	=	2.00	x	@Pi	x ro	
	=	2.00	x	3.14	x 0.20	
	=	1.26	m			
As	=	total circumferential surface area of the pile (m2)				
	=	U	x	Lp		
	=	1.26	x	9.00		
	=	11.31	m2			
N1	=	50.00				
N	=	40.00				
Length pile embedded	=	13.00	m			

axl–alw

III.2.1 Normal condition
N – value of embedded

N–value top	N–value bot.	Elv. top	Elv. bot.	avrg depth	tot depth	avrg N–value	tot. N–value	Kind of soils	soil friction (t/m2)	lixfi
27.00	27.00	31.40	31.393	0.01	0.01	27.00	0.19	silty sand	3.80	0.03
27.00	31.00	31.393	30.393	1.00	1.01	29.00	29.00	do	3.80	3.80
31.00	27.00	30.393	29.393	1.00	2.01	29.00	29.00	do	3.80	3.80
27.00	37.00	29.393	28.393	1.00	3.01	32.00	32.00	do	3.80	3.80
37.00	31.00	28.393	27.393	1.00	4.01	34.00	34.00	do	3.80	3.80
31.00	40.00	27.393	26.393	1.00	5.01	35.50	35.50	do	3.80	3.80
40.00	48.00	26.393	25.393	1.00	6.01	44.00	44.00	fine sand	6.80	6.80
48.00	39.00	25.393	24.393	1.00	7.01	43.50	43.50	do	6.80	6.80
39.00	50.00	24.393	23.393	1.00	8.01	44.50	44.50	do	6.80	6.80
50.00	44.00	23.393	22.393	1.00	9.01	47.00	47.00	do	6.80	6.80
			sum	9.01			338.69		50.00	******

N – value average = 338.69 : 9.01 = 37.60

Material is fine sand

$$N = \frac{N1 + N2'}{2}$$

4 x D	=	4.00	x	0.40				
	=	1.60	m					
N2'	=(	50.00	+	44.00	)2			
	=	47.00						
N	=	(40.00 + 47.00) / 2						
	=	43.50	< 40					
		40						
4.D	=	4.00	x	0.40	=	1.60	m	
l = 1/2 x D	=	0.50	x	1.60	=	0.80	m	
l/D	=	0.80	:	0.40	=	2.00		
qd/N	=	8.00						
qd	=	8.00	x	N				
	=	8.00	x	40.00				
	=	320.00	ton/m2					
A	=	0.25.@pi.d^2						
qd.A	=	320	x	0.1257				
	=	40.21						
U	=	2 x @pi x ro						
	=	2.00	x	3.14	x	0.20		
	=	1.26	m					
Ru	=	qd.A + U.(total li.fi)						
	=	40.21	+	1.26	x	46.23		
	=	98.302	ton					
Lc	=	3.00	m					
Y soil	=	2.00	t/m3					
Ws	=	Effective weight of soil which replace by pile						
	=	0.25	@pi		do^2	Lp	Ysoil	
	=	0.25	x	3.14	x 0.16	x 9.00	x 2.00	
	=	2.26	ton					
W	=	Effective weight of concrete which filled in the pile						
	=	0.25	@pi		x di^2	Lc	Y con.	
	=	0.25	x	3.14	x 0.06	x 3.00	x 2.50	
	=	0.37	ton					

axl–alw

Normal condition,

Force bearing capacity of a pile in abutment

Permanent load safety factor Sn = 3.00

Temporary load safety factor Sq = 2.00

$$Ran = \frac{1}{Sn} \times (Ru - Ws) + Ws - W$$

$$= \frac{1.00}{3.00} \times (98.30 - 2.26) + 2.26 - 0.37$$

$$= 0.33 \times (96.04) + 1.89$$

$$= 32.01 + 1.89$$

$$= 33.91 \text{ ton/nos}$$

b. by material

$$Rp = \text{area of pile} \times \text{compressive stress}$$

$$= (765.7632 \times 350.00) / 3.00 \quad SF = 3.00$$

$$= 89{,}339.04 \text{ kg}$$

$$= 89.34 \text{ ton}$$

R minimum = 33.91 ton

Earth quake condition

$$Raq = \frac{1.00}{2.00} \times (98.30 - 2.26) + 2.26 - 0.37$$

$$= 0.50 \times (96.04) + 1.89$$

$$= 48.02 + 1.89$$

$$= 49.91 \text{ ton/nos}$$

number of piles

Case	V ton		H ton	M ton.m	Allowance bearing a pile Vertical	Allowance bearing a pile Horizontal	Nos of pile Vertical	Nos of pile Horizontal
	Normal condition							
Case-I	HWl	1285.73	178.50	-278.43	33.91	29.99	37.92	5.95
Case-II	LWL	1285.73	153.30	-203.75	33.91	29.99	37.92	5.11
	Earth quake condition							
Case-III	HWl	1225.73	396.13	(590.26	49.91	32.15	24.56	12.32
Case-IV	LWL	1225.73	373.60	-585.62	49.91	32.15	24.56	11.62

axl-alw

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III.3 Spring Constante

III.3.1 Normal condition

Ep	=	Elasticity of precast prestressed pile concrete
h	=	axial length of pile above the design ground surface
Beta	=	charateristic value of pile
k	=	coeficient of horozontal sub grade reaction (kg/cm^2)
IE	=	flexural rigidity of pile
K1,K2,K3&K4	=	spring constante
Kv	=	Axial force (axial spring constante)

do cm	t cm	di=do-2.t cm	do^2 cm2	di^2 cm2	do^2-di^2 cm2	do^4 cm4	di^4 cm4	do^4-di^4 cm4
40	7.50	25.00	1,600	625	975	2,560,000	390,625	2,169,375

$$Ip = @pi/64 \times (do^4 - di^4)$$

$$= 0.0491 \times 2{,}169{,}375$$

$$= 106{,}489 \text{ cm}^4$$

$$Ap = 1/4.@pi.(do^2 - di^2)$$

$$= 0.25 \times 3.14 \times 975$$

$$= 765.76 \text{ cm2}$$

Ep = 343,327 kg/cm2

Lp = 9.00 m = 900 cm

$$a = 0.04 \times \frac{Lp}{do} - 0.27$$

$$= 0.04 \times \frac{900}{40} - 0.27$$

$$= 0.04 \times 22.50 - 0.27$$

$$= 0.9000 - 0.27$$

$$= 0.6300$$

Spring constante on axial force = Kv

$$Kv = a \times \frac{Ap \times Ep}{Lp}$$

$$= 0.6300 \times \frac{765.76 \times 343{,}327}{900}$$

$$= 0.6300 \times 292{,}119$$

$$= 184{,}035 \text{ kg/cm}$$

$$= 18{,}404 \text{ ton/m}$$

$$E.I = 343{,}327 \times 106{,}489$$

$$= 3.656E+10 \text{ kg.cm2}$$

$$4.EI = 4 \times 3.656E+10$$

$$= 1.462E+11 \text{ kg.cm2}$$

$$= 1.462E+11 \times 1.00E-07$$

$$= 14{,}624 \text{ t.m2}$$

kc-n

2.EI	=	7,312	t.m2	
Beta	=	0.588039	m-1	
Beta^2	=	0.34579	m-2	
Beta^3	=	0.2033	m-3	
K1	=	4.EI.Beta^3		
	=	14,624	x	0.2033
	=	2,974	ton/m	
K2=K3	=	2.EI.Beta^2		
	=	7,312	x	0.3458
	=	2,528	ton/rad	
K4	=	2.EI.Beta		
	=	7,312	x	0.5880
	=	4,300	ton.m/rad	

kc-n

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III.3.2 Earthquake condition

Ep	=	Elasticity of precast prestressed pile concrete
h	=	axial length of pile above the design ground surface
Beta	=	charateristic value of pile
k	=	coeficient of horozontal sub grade reaction (kg/cm^2)
IE	=	flexural rigidity of pile
K1,K2,K3&K4	=	spring constante
Kv	=	Axial force (axial spring constante)

do	t	di=do-2.t	do^2	di^2	do^2-di^2	do^4	di^4	do^4-di^4
cm	cm	cm	cm2	cm2	cm2	cm4	cm4	cm4
40	7.50	25.00	1,600	625	975	2,560,000	390,625	2,169,375

Ip = @pi/64 x (do^4-di^4)
= 0.0491 x 2,169,375
= 106,489 cm^4

Ap = 1/4.@pi.(do^2-di^2)
= 0.25 x 3.14 x 975
= 765.76 cm2

Ep = 514,991 kg/cm2

Lp = 9.00 m
= 900 cm

$$a = 0.04 \times \frac{Lp}{do} - 0.27$$

$$= 0.04 \times \frac{900}{40} - 0.27$$

= 0.04 x 22.50 - 0.27
= 0.9000 - 0.27
= 0.6300

Spring constante on axial force = Kv

$$Kv = a \times \frac{Ap}{Lp} \times Ep$$

$$= 0.6300 \times \frac{766}{900} \times 514{,}991$$

= 0.6300 x 438,179
= 276,053 kg/cm
= 27,605 ton/m

EJ = 514,991 x 106,489
= 5.484E+10 kg.cm2

4.EI = 4 x 5.484E+10
= 2.194E+11 kg.cm2
= 2.194E+11 x 1.00E-07
= 21,936 t.m2

kc-pq

2.El	=	10,968	t.m2	
Beta	=	0.526039	m−1	
Beta^2	=	0.27672	m−2	
Beta^3	=	0.1456	m−3	
K1	=	4.El.Beta^3		
	=	21,936	x	0.1456
	=	3,193	ton/m	
	=			
K2=K3	=	2.El.Beta^2		
	=	10,968	x	0.2767
	=	3,035	ton/rad	
K4	=	2.El.Beta		
	=	10,968	x	0.5260
	=	5,770	ton.m/rad	

kc−pq

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III.4 Displacement of head footing

III.4.1 Normal Condition

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)
Axy = tot.(Kv − K1) x sin ø x cos ø)
Ayx = tot.(Kv − K1) x sin ø x cos ø)
Axa = tot.(KV − K1) x Xi x (sin ø x cos ø) − (K2 x cos ø))
Aax = tot.(KV − K1) x Xi x (sin ø x cos ø) − (K2 x cos ø))
Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))
Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aay = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi ^2 ^ + (K2 + K3).Xi sin ø + K4)

Abutment		Rows				Total
Nos. of row		(1)	(2)	(3)	(4)	
side		L/s	L/s	R/s	R/s	
sign		(−)	(−)	(+)	(+)	
angle		< 0	< 0	> 0	> 0	
Xi	=	(1.875)	(0.625)	0.625	1.875	
n	=	7.00	7.00	7.00	7.00	
angle degree	=	0.0000	0.0000	0.0000	5.71	
sin ø	=	0.0000	0.00	0.00	0.10	
cos ø	=	1.0000	1.0000	1.0000	0.9950	
sin ø x cosø	=	0.0000	0.00	0.00	0.10	
sin ^2 ø	=	0.0000	0.00	0.00	0.01	
cos ^2 ø	=	1.0000	1.0000	1.0000	0.9901	
Xi ^2	=	3.5156	0.3906	0.3906	3.5156	
K1	=	2,974.00	2,974.00	2,974.00	2,974.00	
K2	=	2,528.00	2,528.00	2,528.00	2,528.00	
K3	=	2,528.00	2,528.00	2,528.00	2,528.00	
K4	=	4,300.00	4,300.00	4,300.00	4,300.00	
Kv	=	18,404.00	18,404.00	18,404.00	18,404.00	
n.K1	=	20,818	20,818	20,818	20,818	
n.K2	=	17,696	17,696	17,696	17,696	
n.K3	=	17,696	17,696	17,696	17,696	
n.K4	=	30,100	30,100	30,100	30,100	
n.Kv	=	128,828	128,828	128,828	128,828	
n.(K2 + K3)	=	35,392	35,392	35,392	35,392	
Xi.(n.(K2 + K3))	=	(66,360)	(22,120)	22,120	66,360	
Xi.(n.(K2 + K3)).sin ø	=	0	0	0	6,602	
n.(Kv−K1)	=	108,010	108,010	108,010	108,010	
n.(Kv−K1).sin ø.cosø	=	0	0	0	10,693	
n.K1.cos ^2 ø	=	20,818	20,818	20,818	20,612	
n.Kv.sin ^2 ø	=	0	0	0	1,275	
n.Kv.cos ^2 ø	=	128,828	128,828	128,828	127,553	
n.K1.sin ^2 ø	=	0	0	0	206	
n.K1.sin ø.cosø	=	0	0	0	2,061	
n.Kv.sin ø.cosø	=	0	0	0	12,754	
Xi.(n.K1.sin ø.cos ø)	=	0	0	0	3,864	
Xi.(n.Kv.sin ø.cos ø)	=	0	0	0	23,914	
n.K2.cos ø	=	17,696	17,696	17,696	17,608	
n.K2.sin ø	=	0	0	0	1,761	
n.K3.sin ø	=	0	0	0	1,761	
Xi.(n.Kv.cos ^2 ø)	=	(241,553)	(80,518)	80,518	239,161	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	386	

coe−disn

Xi^2.(n.Kv.cos ^2 ø)	=	452.911	50.323	50.323	448.428	
Xi^2.(n.K1.sin^2 ø)	=	0	0	0	724	
Xi.(n.K2.sin ø)	=	0	0	0	3.301	
Xi.(n.K3.sin ø)	=	0	0	0	3.301	

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)

n.K1.cos^2 ø	=	20.818	20.818	20.818	20.612	
n.Kv.sin^2 ø	=	0	0	0	1.275	
total		20.818	20.818	20.818	21.887	84.341

Axy = tot.(Kv – K1) x sin ø x cos ø)

n.(Kv–K1).sin ø.cosø	=	0	0	0	10.693	
A xy	=	0	0	0	10.693	10.693
A yx	=	0	0	0	10.693	10.693

Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))

Xi.(n.(Kv – K1).sin ø.cc	=	0	0	0	20.049	
– n.K2.cos ø	=	(17.696)	(17.696)	(17.696)	(17.608)	
Axa		(17.696)	(17.696)	(17.696)	2.441	(50.647)
Aax	=	(17.696)	(17.696)	(17.696)	2.441	(50.647)

Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))

n.Kv.cos ^2 ø	=	128.828	128.828	128.828	127.553	
n.K1.sin ^2 ø	=	0	0	0	206	
Ayy		128.828	128.828	128.828	127.759	514.243

Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)

Xi.(n.Kv.cos ^2 ø)	=	(241.553)	(80.518)	80.518	239.161	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	386	
n.K2.sin ø	=	0	0	0	1.761	
Aya	=	(241.553)	(80.518)	80.518	241.308	(244)
Aay	=	(241.553)	(80.518)	80.518	241.308	(244)

Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi ^2 ^+ (K2+K3) Xi sin ø + K4)

Xi^2.(n.Kv.cos ^2 ø)	=	452.911	50.323	50.323	448.428	
Xi^2.(n.K1.sin^2 ø)	=	0	0	0	724	
n.(K2+K3).Xi.sin ø	=	0	0	0	6.602	
n.K4	=	30.100	30.100	30.100	30.100	
Aaa		483.011	80.423	80.423	485.854	1.129.712

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III.4.2 Earthquake Condition

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)
Axy = tot.(Kv – K1) x sin ø x cos ø)
Ayx = tot.(Kv – K1) x sin ø x cos ø)
Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Aax = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))
Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))
Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aay = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)
Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi ^2 ^ + (K2 + K3).Xi sin ø + K4)

Abutment		Rows				Total
Nos. of row		(1)	(2)	(3)	(4)	
side		L/s	L/s	R/s	R/s	
sign		(–)	(–)	(+)	(+)	
angle		< 0	< 0	> 0	> 0	
Xi	=	(1.875)	(0.625)	0.625	1.875	
n	=	7.00	7.00	7.00	7.00	
angle degree	=	0.0000	0.0000	0.0000	5.71	
sin ø	=	0.0000	0.00	0.00	0.10	
cos ø	=	1.0000	1.0000	1.0000	0.9950	
sin ø x cosø	=	0.0000	0.00	0.00	0.10	
sin ^2 ø	=	0.0000	0.00	0.00	0.01	
cos^2 ø	=	1.0000	1.0000	1.0000	0.9901	
Xi^2	=	3.5156	0.3906	0.3906	3.5156	
K1	=	3,193.00	3,193.00	3,193.00	3,193.00	
K2	=	3,035.00	3,035.00	3,035.00	3,035.00	
K3	=	3,035.00	3,035.00	3,035.00	3,035.00	
K4	=	5,770.00	5,770.00	5,770.00	5,770.00	
Kv	=	27,605.00	27,605.00	27,605.00	27,605.00	
n.K1	=	22.351	22.351	22.351	22.351	
n.K2	=	21.245	21.245	21.245	21.245	
n.K3	=	21.245	21.245	21.245	21.245	
n.K4	=	40.390	40.390	40.390	40.390	
n.Kv	=	193.235	193.235	193.235	193.235	
n.(K2 + K3)	=	42.490	42.490	42.490	42.490	
Xi.(n.(K2 + K3))	=	(79.669)	(26.556)	26.556	79.669	
Xi.(n.(K2 + K3)).sin ø	=	0	0	0	7.927	
n.(Kv–K1)	=	170.884	170.884	170.884	170.884	
n.(Kv–K1).sin ø.cosø	=	0	0	0	16.917	
n.K1.cos^2 ø	=	22.351	22.351	22.351	22.130	
n.Kv.sin^2 ø	=	0	0	0	1.913	
n.Kv.cos^2 ø	=	193.235	193.235	193.235	191.322	
n.K1.sin^2 ø	=	0	0	0	221	
n.K1.sin ø.cosø	=	0	0	0	2.213	
n.Kv.sin ø.cosø	=	0	0	0	19.130	
Xi.(n.K1.sin ø.cos ø)	=	0	0	0	4.149	
Xi.(n.Kv.sin ø.cos ø)	=	0	0	0	35.869	
n.K2.cos ø	=	21.245	21.245	21.245	21.140	
n.K2.sin ø	=	0	0	0	2.114	
n.K3.sin ø	=	0	0	0	2.114	
Xi.(n.Kv.cos ^2 ø)	=	(362.316)	(120.772)	120.772	358.729	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	415	

Xi^2.(n.Kv.cos ^2 ø)	=	679,342	75,482	75,482	672,617	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	778	
Xi.(n.K2.sin ø)	=	0	0	0	3,963	
Xi.(n.K3.sin ø)	=	0	0	0	3,963	

Axx = tot.(K1 x cos^2 ø + Kv x sin ^2 ø)

n.K1.cos ^2 ø	=	22,351	22,351	22,351	22,130	
n.Kv.sin ^2 ø	=	0	0	0	1,913	
total		22,351	22,351	22,351	24,043	91,096

Axy = tot.(Kv – K1) x sin ø x cos ø)

n.(Kv–K1).sin ø.cosø	=	0	0	0	16,917	
A xy	=	0	0	0	16,917	16,917
A yx	=	0	0	0	16,917	16,917

Axa = tot.(KV – K1) x Xi x (sin ø x cos ø) – (K2 x cos ø))

Xi.(n.(Kv – K1).sin ø.cx	=	0	0	0	31,720	
– n.K2.cos ø	=	(21,245)	(21,245)	(21,245)	(21,140)	
Axa		(21,245)	(21,245)	(21,245)	10,581	(53,154)
Aax	=	(21,245)	(21,245)	(21,245)	10,581	(53,154)

Ayy = tot.(KV x cos ^2 ø + (K1 x sin ^2 ø))

n.Kv.cos ^2 ø	=	193,235	193,235	193,235	191,322	
n.K1.sin ^2 ø	=	0	0	0	221	
Ayy		193,235	193,235	193,235	191,543	771,248

Aya = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi + K2 x sin ø)

Xi.(n.Kv.cos ^2 ø)	=	(362,316)	(120,772)	120,772	358,729	
Xi.(n.K1.sin ^2 ø)	=	0	0	0	415	
n.K2.sin ø	=	0	0	0	2,114	
Aya	=	(362,316)	(120,772)	120,772	361,258	(1,058)
Aay	=	(362,316)	(120,772)	120,772	361,258	(1,058)

Aaa = tot.(KV x cos ^2 ø + K1 x sin ^2 ø) x Xi^2 ^+ (K2+K3) Xi sin ø + K4)

Xi^2.(n.Kv.cos ^2 ø)	=	679,342	75,482	75,482	672,617	
Xi^2.(n.K1.sin ^2 ø)	=	0	0	0	778	
n.(K2+K3).Xi.sin ø	=	0	0	0	7,927	
n.K4	=	40,390	40,390	40,390	40,390	
Aaa		719,732	115,872	115,872	721,711	1,673,188

coe–disq

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – FS Station : Fw 26 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.5 Coefficient displacement of footing
III.5.1 Case – I ,Normal condition (I-IWL)

Axx	dx	+	Axy	dy	+	Axz	dz	=	H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	=	V
Azx	dx	+	Azy	dy	+	Azz	dz	=	M

85,888	dx	+	0	dy	+	(21,544)	dz	= 10.00 H
0	dx	+	809,296	dy	+	0	dz	= 850.77 V
(21,544)	dx	+	0	dy	+	1,319,547	dz	= (168.41) M

det A

8.569E+04	809296	–
	0	1319547
0	0	–
	–21544	1319547
–21544	0	809296 –
	–21544	0

+	85888	x(	809296	x	1319547	–	0	x	0)	
	85888	x(	803994709912	–	0	)				= 8.91E+16
–	0	x(	0	x	1319547	–	–21544	x	0)	
	0	x(	0	–	0	)				= 0.00E+00
+	–21544	x(	0	x	0	–	–21544	x	809296)	
	–21544	x(	0	–	1.313E+10	)				= –2.83E+14
										8.66E+16

$$\frac{1}{\det} = \frac{1}{8.66E+16}$$

Kolector

a11	8.09E+05	0.00E+00	+(	8.09E+05	x	1.32E+06	)–(	0.00E+00	x	0.00E+00	)=	C11
	0.00E+00	1.32E+06	+(	8.04E+11			)–(	0.00E+00	)		=	8.04E+11
a12	0.00E+00	0.00E+00	–(	0.00E+00	x	1.32E+06	)–(–2.15E+04	x	0.00E+00	)=	C12
	–2.15E+04	1.32E+06	–(	0.00E+00			)–(	0.00E+00	)		=	0.00E+00
a13	0.00E+00	8.09E+05	+(	0.00E+00	x	0.00E+00	)–(–2.15E+04	x	8.09E+05	)=	C13
	–2.15E+04	0.00E+00	+(	0.00E+00			)–(–1.31E+10	)		=	1.31E+10
a21	0.00E+00	–2.15E+04	–(	0.00E+00	x	1.32E+06	)–(	0.00E+00	x	–2.15E+04	)=	C21
	0.00E+00	1.32E+06	–(	0.00E+00			)–(	0.00E+00	)		=	0.00E+00
a22	8.56E+04	–2.15E+04	+(	8.56E+04	x	1.32E+06	– –2.15E+04	x	–2.15E+04	)=	C22
	–2.15E+04	1.32E+06	+(	1.13E+11			– 4.84E+06	)		=	1.13E+11
a23	8.56E+04	0.00E+00	+(	8.56E+04	x	0.00E+00	– –2.15E+04	x	0.00E+00	)=	C23
	–2.15E+04	0.00E+00	+(	0.00E+00			– 0.00E+00	)		=	0.00E+00
a31	0.00E+00	–2.15E+04	+(	0.00E+00	x	0.00E+00	– 8.09E+05	x	–2.15E+04	)=	C31
	8.09E+05	0.00E+00	+(	0.00E+00			– –1.31E+10	)		=	1.31E+10
a32	8.56E+04	–2.15E+04	–(	8.56E+04	x	0.00E+00	– 0.00E+00	x	–2.15E+04	)=	C32
	0.00E+00	0.00E+00	–(	0.00E+00			– 0.00E+00	)		=	0.00E+00
a33	8.56E+04	0.00E+00	+(	8.56E+04	x	8.09E+05	– 0.00E+00	x	0.00E+00	)=	C33
	0.00E+00	8.09E+05	+(	5.23E+10			– 0.00E+00	)		=	5.23E+10

C =

8.04E+11	0.00E+00	1.31E+10
0.00E+00	1.13E+11	0.00E+00
1.31E+10	0.00E+00	5.23E+10

Adj C = Ci =

8.04E+11	0.00E+00	1.31E+10
0.00E+00	1.13E+11	0.00E+00
1.31E+10	0.00E+00	5.23E+10

$$A^{-1} = \frac{\text{adj A}}{\det A} = \frac{1}{\det A} \times$$

8.04E+11	0.00E+00	1.31E+10
0.00E+00	1.13E+11	0.00E+00
1.31E+10	0.00E+00	5.23E+10

=

1.00E+01	8.51E+02	–1.88E+02
1.00E+01	8.51E+02	–1.88E+02
1.00E+01	8.51E+02	–1.88E+02

$$X = A^{-1}.b = \frac{1.00E+00}{8.66E+16} \times$$

8.04E+12	0.00E+00	–2.47E+12
0.00E+00	9.80E+13	0.00E+00
1.31E+11	0.00E+00	–9.66E+12

$$X = \frac{1.00E+00}{8.66E+16} \times$$

5.57E+12	8.09E–05
9.80E+13	= 1.40E–03
–9.73E+12	–1.41E–04

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{matrix} 0.00008095 \\ 0.00139632 \\ (0.00014146) \end{matrix}$$

Control

0.00	dx	+	809,296.00	dy	+	0.00	dz	= 850.77
0		x	0.0000809466		=	0		
809296		x	0.0013963184		=	850.77		
0		x	–0.0001414622		=	0		
						850.77	=	850.77

def–1

Project	: Medan Flood Control
Channel	: Medan Flood Way
Structure	: Br – F 3
Station	: Fw 26 + 22

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III.5.2 Case – II, Normal condition (LWL)

Axx	dx	+	Axy	dy	+	Axz	dz	=	H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	=	V
Azx	dx	+	Azy	dy	+	Azz	dz	=	M

85,888	dx	+	0	dy	+	(21,544)	dz	=	10.00 H
0	dx	+	809,296	dy	+	0	dz	=	1,082.03 V
(21,544)	dx	+	0	dy	+	1,319,547	dz	=	(32.20) M

det A

8.589E+04	809296	0
0	0	1319547
	0	0
−21544	−21544	1319547
	0	809296
	−21544	0

+	85888	x(	809296	x	1319547	−	0	x	0)			
	85888	x(	803994708912	−	0	)				=	8.91E+16	
−	0	x(	0	x	1319547	−	−21544	x	0)			
	0	x(	0	−	0	)				=	0.00E+00	
+	−21544	x(	0	x	0	−	−21544	x	809296)			
	−21544	x(	0	−	1.313E+10	)				=	−2.83E+14	
											8.66E+16	

$$\frac{1}{\det} = \frac{1}{8.66E+16}$$

Kofactor

a11	8.09E+05		0.00E+00	+(	8.09E+05	x	1.32E+06	)−(	0.00E+00	x	0.00E+00	)=	C11
	0.00E+00		1.32E+06	+(	8.04E+11			)−(	0.00E+00	)		=	8.04E+11
a12	0.00E+00		0.00E+00	−(	0.00E+00	x	1.32E+06	)−(	−2.15E+04	x	0.00E+00	)=	C12
	−2.15E+04		1.32E+06	−(	0.00E+00			)−(	0.00E+00	)		=	0.00E+00
a13	0.00E+00		8.09E+05	+(	0.00E+00	x	0.00E+00	)−(	−2.15E+04	x	8.09E+05	)=	C13
	−2.15E+04		0.00E+00	+(	0.00E+00			)−(	−1.31E+10	)		=	1.31E+10
a21	0.00E+00		−2.15E+04	−(	0.00E+00	x	1.32E+06	)−(	0.00E+00	x	−2.15E+04	)=	C21
	0.00E+00		1.32E+06	−(	0.00E+00			)−(	0.00E+00	)		=	0.00E+00
a22	8.59E+04		−2.15E+04	+(	8.59E+04	x	1.32E+06	−	−2.15E+04	x	−2.15E+04	)=	C22
	−2.15E+04		1.32E+06	+(	1.13E+11			−	4.64E+06	)		=	1.13E+11
a23	8.59E+04		0.00E+00	+(	8.59E+04	x	0.00E+00	−	−2.15E+04	x	0.00E+00	)=	C23
	−2.15E+04		0.00E+00	+(	0.00E+00			−	0.00E+00	)		=	0.00E+00
a31	0.00E+00		−2.15E+04	+(	0.00E+00	x	0.00E+00	−	8.09E+05	x	−2.15E+04	)=	C31
	8.09E+05		0.00E+00	+(	0.00E+00			−	−1.31E+10	)		=	1.31E+10
a32	8.59E+04		−2.15E+04	−(	8.59E+04	x	0.00E+00	−	0.00E+00	x	−2.15E+04	)=	C32
	0.00E+00		0.00E+00	−(	0.00E+00			−	0.00E+00	)		=	0.00E+00
a33	8.59E+04		0.00E+00	+(	8.59E+04	x	8.09E+05	−	0.00E+00	x	0.00E+00	)=	C33
	0.00E+00		8.09E+05	+(	5.23E+10			−	0.00E+00	)		=	5.23E+10

C =

8.04E+11	0.00E+00	1.31E+10
0.00E+00	1.13E+11	0.00E+00
1.31E+10	0.00E+00	5.23E+10

Adj C = Ct =

8.04E+11	0.00E+00	1.31E+10
0.00E+00	1.13E+11	0.00E+00
1.31E+10	0.00E+00	5.23E+10

$$A^{-1} = \frac{\text{adj } A}{\det A} = \frac{1}{\det A} \times \begin{vmatrix} 8.04E+11 & 0.00E+00 & 1.31E+10 \\ 0.00E+00 & 1.13E+11 & 0.00E+00 \\ 1.31E+10 & 0.00E+00 & 5.23E+10 \end{vmatrix} = \begin{vmatrix} 1.00E+01 & 0.00E+00 & 1.08E+03 \\ 0.00E+00 & 1.08E+03 & 0.00E+00 \\ 1.08E+03 & 0.00E+00 & -3.22E+01 \end{vmatrix}$$

8.04E+11	x	1.00E+01	+	0.00E+00	x	1.08E+03	+	1.31E+10	x	−3.22E+01				
0.00E+00	x	1.00E+01	+	1.13E+11	x	1.08E+03	+	0.00E+00	x	−3.22E+01				
1.31E+10	x	1.00E+01	+	0.00E+00	x	1.08E+03	+	5.23E+10	x	−3.22E+01				

$$X = A^{-1}.b = \frac{1.00E+00}{8.66E+16} \times \begin{vmatrix} 8.04E+12 & 0.00E+00 & -4.23E+11 \\ 0.00E+00 & 1.22E+14 & 0.00E+00 \\ 1.31E+11 & 0.00E+00 & -1.69E+12 \end{vmatrix} =$$

$$X = \frac{1.00E+00}{8.66E+16} \times \begin{vmatrix} 7.82E+12 \\ 1.22E+14 \\ -1.55E+12 \end{vmatrix} = \begin{vmatrix} 1.11E-04 \\ 1.78E-03 \\ -2.26E-05 \end{vmatrix}$$

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{matrix} 0.00011076 \\ 0.00177567 \\ (0.00002259) \end{matrix}$$

Control

0.00	dx	+	809,296.00	dy	+	0.00	dz	= 1,082.03
0	x	0.0001107633	=	0				
809296	x	0.0017758892	=	1082.03				
0	x	−0.0000225939	=	0				
				1082.03	=	1082.03		

def–h2

Project	: Medan Flood Control
Channel	: Medan Flood Way
Structure	: Br – F 3
Station	: Fw 26 + 22

Japan International Cooperation Agency (JICA)

Calculation sheet	
Date	
Nos of sheet	
Prepared by	

III.5.3 Case – III, Earthquake condition (HWL)

Axx	dx	+	Axy	dy	+	Axz	dz	=	H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	=	V
Azx	dx	+	Azy	dy	+	Azz	dz	=	M

94,564	dx	+	0	dy	+	(8,070)	dz	=	114.73 H
0	dx	+	919,824	dy	+	0	dz	=	850.77 V
(8,070)	dx	+	0	dy	+	1,967,845	dz	=	(641.26) M

det A

9.456E+04	919824	0
0	0	1967845
	0	0
−8070	−8070	1967845
	0	919824
	−8070	0

+	94564	x(	919824	x	1967845	−	0	x	0)			
	94564	x(	1809677490280	−	0	)				=	1.71E+17	
−	0	x(	0	x	1967845	−	−8070	x	0)			
	0	x(	0	−	0	)				=	0.00E+00	
+	−8070	x(	0	x	0	−	−8070	x	919824)			
	−8070	x(	0	−	7421365680	)				=	−5.99E+13	
											1.71E+17	

$$\frac{1}{\det} = \frac{1}{1.71E+17}$$

Kofactor

a11	9.20E+05		0.00E+00	+(	9.20E+05	x	1.97E+06	)−(	0.00E+00	x	0.00E+00	)=	C11
	0.00E+00		1.97E+06	+(	1.81E+12			)−(	0.00E+00	)		=	1.81E+12
a12	0.00E+00		0.00E+00	−(	0.00E+00	x	1.97E+06	)−(	−8.07E+03	x	0.00E+00	)=	C12
	−8.07E+03		1.97E+06	−(	0.00E+00			)−(	0.00E+00	)		=	0.00E+00
a13	0.00E+00		9.20E+05	+(	0.00E+00	x	0.00E+00	)−(	−8.07E+03	x	9.20E+05	)=	C13
	−8.07E+03		0.00E+00	+(	0.00E+00			)−(	−7.42E+09	)		=	7.42E+09
a21	0.00E+00		−8.07E+03	−(	0.00E+00	x	1.97E+06	)−(	0.00E+00	x	−8.07E+03	)=	C21
	0.00E+00		1.97E+06	−(	0.00E+00			)−(	0.00E+00	)		=	0.00E+00
a22	9.46E+04		−8.07E+03	+(	9.46E+04	x	1.97E+06	−	−8.07E+03	x	−8.07E+03	)=	C22
	−8.07E+03		1.97E+06	+(	1.86E+11			−	6.51E+07	)		=	1.86E+11
a23	9.46E+04		0.00E+00	+(	9.46E+04	x	0.00E+00	−	−8.07E+03	x	0.00E+00	)=	C23
	−8.07E+03		0.00E+00	+(	0.00E+00			−	0.00E+00	)		=	0.00E+00
a31	0.00E+00		−8.07E+03	+(	0.00E+00	x	0.00E+00	−	9.20E+05	x	−8.07E+03	)=	C31
	9.20E+05		0.00E+00	+(	0.00E+00			−	−7.42E+09	)		=	7.42E+09
a32	9.46E+04		−8.07E+03	−(	9.46E+04	x	0.00E+00	−	0.00E+00	x	−8.07E+03	)=	C32
	0.00E+00		0.00E+00	−(	0.00E+00			−	0.00E+00	)		=	0.00E+00
a33	9.46E+04		0.00E+00	+(	9.46E+04	x	9.20E+05	−	0.00E+00	x	0.00E+00	)=	C33
	0.00E+00		9.20E+05	+(	8.70E+10			−	0.00E+00	)		=	8.70E+10

C =

1.81E+12	0.00E+00	7.42E+09
0.00E+00	1.86E+11	0.00E+00
7.42E+09	0.00E+00	8.70E+10

Adj C = Ct =

1.81E+12	0.00E+00	7.42E+09
0.00E+00	1.86E+11	0.00E+00
7.42E+09	0.00E+00	8.70E+10

$$A^{-1} = \frac{\text{adj } A}{\det A} = \frac{1}{\det A} \times \begin{vmatrix} 1.81E+12 & 0.00E+00 & 7.42E+09 \\ 0.00E+00 & 1.86E+11 & 0.00E+00 \\ 7.42E+09 & 0.00E+00 & 8.70E+10 \end{vmatrix} = \begin{vmatrix} 1.15E+02 & 0.00E+00 & 8.51E+02 \\ 0.00E+00 & 8.51E+02 & 0.00E+00 \\ 8.51E+02 & 0.00E+00 & -6.41E+02 \end{vmatrix}$$

1.81E+12	x	1.15E+02	+	0.00E+00	x	8.51E+02	+	7.42E+09	x	−6.41E+02				
0.00E+00	x	1.15E+02	+	1.86E+11	x	8.51E+02	+	0.00E+00	x	−6.41E+02				
7.42E+09	x	1.15E+02	+	0.00E+00	x	8.51E+02	+	8.70E+10	x	−6.41E+02				

$$X = A^{-1}.b = \frac{1.00E+00}{1.71E+17} \times \begin{vmatrix} 2.08E+14 & 0.00E+00 & -4.76E+12 \\ 0.00E+00 & 1.58E+14 & 0.00E+00 \\ 8.51E+11 & 0.00E+00 & -5.58E+13 \end{vmatrix} =$$

$$X = \frac{1.00E+00}{1.71E+17} \times \begin{vmatrix} 2.03E+14 \\ 1.58E+14 \\ -5.40E+13 \end{vmatrix} = \begin{vmatrix} 1.19E-03 \\ 9.25E-04 \\ -3.21E-04 \end{vmatrix}$$

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{matrix} 0.00118586 \\ 0.00092513 \\ (0.00032102) \end{matrix}$$

Control

0.00	dx	+	919,824.00	dy	+	0.00	dz	= 850.77
0	x	0.0011658572	=	0				
919824	x	0.0009251281	=	850.77				
0	x	−0.0003210182	=	0				
				850.77	=	850.77		

def–h3

Project	: Medan Flood Control
Channal	: Medan Flood Way
Structure	: Br – F 3
Station	: Fw 26 + 22

Japan International Cooperation Agency (JICA)

Calculation sheet	
Date	
Nos of sheet	
Prepared by	

III.5.4 Case – IV ,Earthquake condition (LWL)

Axx	dx	+	Axy	dy	+	Axz	dz	= H
Ayx	dx	+	Ayy	dy	+	Ayz	dz	= V
Azx	dx	+	Azy	dy	+	Azz	dz	= M

94,564	dx	+	0	dy	+	(8,070)	dz	= 141.80 H
0	dx	+	919,624	dy	+	0	dz	= 1,082.03 V
(8,070)	dx	+	0	dy	+	1,967,845	dz	= (312.03) M

det A

8.456E+04	919624	0 =
	0	1967845
0	0	0 =
	−8070	1967845
−8070	0	919624 =
	−8070	0

+	94564	x(	919624	x	1967845	−	0	x	0)	
	94564	x(	1809677480260	−	0	)				= 1.71E+17
−	0	x(	0	x	1967845	−	−8070	x	0)	
	0	x(	0	−	0	)				= 0.00E+00
+	−8070	x(	0	x	0	−	−8070	x	919624)	
	−8070	x(	0	−	7421365680	)				= −5.99E+13
										1.71E+17

$$\frac{1}{\text{det}} = \frac{1}{1.71E+17}$$

Kofactor

a11	9.20E+05	0.00E+00	+ (	9.20E+05	x	1.97E+06	) − (	0.00E+00	x	0.00E+00	) =	C11
	0.00E+00	1.97E+06	+ (	1.81E+12			) − (	0.00E+00	)		=	1.81E+12
a12	0.00E+00	0.00E+00	− (	0.00E+00	x	1.97E+06	) − (	−8.07E+03	x	0.00E+00	) =	C12
	−8.07E+03	1.97E+06	− (	0.00E+00			) − (	0.00E+00	)		=	0.00E+00
a13	0.00E+00	9.20E+05	+ (	0.00E+00	x	0.00E+00	) − (	−8.07E+03	x	9.20E+05	) =	C13
	−8.07E+03	0.00E+00	+ (	0.00E+00			) − (	−7.42E+09	)		=	7.42E+09
a21	0.00E+00	−8.07E+03	− (	0.00E+00	x	1.97E+06	) − (	0.00E+00	x	−8.07E+03	) =	C21
	0.00E+00	1.97E+06	− (	0.00E+00			) − (	0.00E+00	)		=	0.00E+00
a22	9.46E+04	−8.07E+03	+ (	9.46E+04	x	1.97E+06	−	−8.07E+03	x	−8.07E+03	) =	C22
	−8.07E+03	1.97E+06	+ (	1.86E+11			−	6.51E+07	)		=	1.86E+11
a23	9.46E+04	0.00E+00	+ (	9.46E+04	x	0.00E+00	−	−8.07E+03	x	0.00E+00	) =	C23
	−8.07E+03	0.00E+00	+ (	0.00E+00			−	0.00E+00	)		=	0.00E+00
a31	0.00E+00	−8.07E+03	+ (	0.00E+00	x	0.00E+00	−	9.20E+05	x	−8.07E+03	) =	C31
	9.20E+05	0.00E+00	+ (	0.00E+00			−	−7.42E+09	)		=	7.42E+09
a32	9.46E+04	−8.07E+03	− (	9.46E+04	x	0.00E+00	−	0.00E+00	x	−8.07E+03	) =	C32
	0.00E+00	0.00E+00	− (	0.00E+00			−	0.00E+00	)		=	0.00E+00
a33	9.46E+04	0.00E+00	+ (	9.46E+04	x	9.20E+05	−	0.00E+00	x	0.00E+00	) =	C33
	0.00E+00	9.20E+05	+ (	8.70E+10			−	0.00E+00	)		=	8.70E+10

C =

1.81E+12	0.00E+00	7.42E+09
0.00E+00	1.86E+11	0.00E+00
7.42E+09	0.00E+00	8.70E+10

Adj C = Ct =

1.81E+12	0.00E+00	7.42E+09
0.00E+00	1.86E+11	0.00E+00
7.42E+09	0.00E+00	8.70E+10

$$A^{-1} = \frac{\text{adj A}}{\det A} = \frac{1}{\det A} \times \begin{vmatrix} 1.81E+12 & 0.00E+00 & 7.42E+09 \\ 0.00E+00 & 1.86E+11 & 0.00E+00 \\ 7.42E+09 & 0.00E+00 & 8.70E+10 \end{vmatrix}$$

$$\begin{vmatrix} 1.81E+12 & 1.42E+02 & 0.00E+00 & 1.06E+03 & 7.42E+09 & -3.12E+02 \\ 0.00E+00 & 1.42E+02 & 1.86E+11 & 1.06E+03 & 0.00E+00 & -3.12E+02 \\ 7.42E+09 & 1.42E+02 & 0.00E+00 & 1.06E+03 & 8.70E+10 & -3.12E+02 \end{vmatrix}$$

$$X = A^{-1}.b = \frac{1.00E+00}{1.71E+17} \times \begin{vmatrix} 2.57E+14 & 0.00E+00 & -2.32E+12 \\ 0.00E+00 & 2.01E+14 & 0.00E+00 \\ 1.05E+12 & 0.00E+00 & -2.71E+13 \end{vmatrix} =$$

$$X = \frac{1.00E+00}{1.71E+17} \times \begin{vmatrix} 2.54E+14 \\ 2.01E+14 \\ -2.61E+13 \end{vmatrix} = \begin{vmatrix} 1.49E-03 \\ 1.18E-03 \\ -1.52E-04 \end{vmatrix}$$

$$X = \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix} = \begin{matrix} 0.00148650 \\ 0.00117660 \\ (0.00015247) \end{matrix}$$

Control

0.00	dx	+	919,624.00	dy	+	0.00	dz = 1,082.03
0	x		0.0014865021		=	0	
919624	x		0.0011766004		=	1082.03	
0	x		−0.0001524683		=	0	
						1082.03	= 1082.03

det-h4

Project	: Medan Flood Control
Channel	: Medan Flood Way
Structure	: Br – F3
Station	: FW 28 + 22

Japan International Cooperation Agency (JICA)

Calculation sheet	
Date	
Nos of sheet	
Prepared by	

III.6 Force at each pile head
III.6.1 Case – I ,Normal condition (HWL)

dxi = (dxi.cos α) – (dy + alpa.Xi).sin α)
dyi = (dxi.sin α) + (dy + alpa.Xi)cos α)

		Side	Row of pile (1)	(2)	(3)	(4)	total
		sign	L/s (−)	L/s (−)	R/s (+)	R/s (+)	per row
		degree	< 0			> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			7.00	7.00	7.00	7.00	
α	degree		0.00	0.00	0.00	5.71	
cos α	degree		1.000	1.000	1.000	0.995	
sin α	degree		0.000	0.000	0.000	0.099	
K1	t.m		2,974	2,974	2,974	2,974	
K2	t.m/rad		2,528	2,528	2,528	2,528	
K3	t.m/rad		2,528	2,528	2,528	2,528	
K4	t.m		4,300	4,300	4,300	4,300	
Kv	t.m		18,404	18,404	18,404	18,404	
dx	m		0.00170206	0.00170206	0.00170206	0.00170206	
dy	m		0.00246477	0.00246477	0.00246477	0.00246477	
alpa	rad		(0.00016962)	(0.00016962)	(0.00016962)	(0.00016962)	
dxi = dx cos α – (dy + alpa.Xi).sin α							
dx.cos α	=		0.00170	0.00170	0.00170	0.00169	
dy	=		0.00246	0.00246	0.00246	0.00246	
alpa	=		(0.00017)	(0.00017)	(0.00017)	(0.00017)	
Alpa x Xi	=		0.00032	0.00011	(0.00011)	(0.00032)	
dy + Alpa x Xi	=		0.00278	0.00257	0.00236	0.00215	
(dy + alpa.Xi).sin α	=		0.00000	0.00000	0.00000	0.00021	
dxi	=		0.00170	0.00170	0.00170	0.00148	
dyi = dx sin α + (dy + alpa.Xi).cos α							
dx.sin α	=		0.0000000	0.0000000	0.0000000	0.0001693	
dy	=		0.0024648	0.0024648	0.0024648	0.0024648	
alpa	=		(0.0001696)	(0.0001696)	(0.0001696)	(0.0001696)	
Alpa x Xi	=		0.0003180	0.0001060	(0.0001060)	(0.0003180)	
dy + Alpa x Xi	=		0.0027828	0.0025708	0.0023588	0.0021467	
(dy + alpa.Xi).cos α	=		0.0027828	0.0025708	0.0023588	0.0021361	
dyi	=		0.0027828	0.0025708	0.0023588	0.0023054	
P ni=Kv.dyi			51.21	47.31	43.41	42.43	
K1.dxi	=		5.06	5.06	5.06	4.40	
K2.alpa	=		(0.43)	(0.43)	(0.43)	(0.43)	
P hi=K1.dxi–K2.alpa	=		5.49	5.49	5.49	4.83	
K3.dxi	=		4.30	4.30	4.30	3.74	
K4.alpa	=		(0.73)	(0.73)	(0.73)	(0.73)	
M ti=–K3.dxi+K4.alpa	=		(5.03)	(5.03)	(5.03)	(4.47)	(19.57)
Mti x n	=		(35.23)	(35.23)	(35.23)	(31.30)	(136.97)
Vi = Pni.cos α – Phi.sin α							
Pni.cos	=		51.21	47.31	43.41	42.22	
Phi.sin α	=		0.00	0.00	0.00	0.48	
Vi	=		51.21	47.31	43.41	41.74	
Vi.n	=		358.50	331.19	303.87	292.17	1,285.73
Hi= Pni.sin α + Phi.cos α							
Pni.sin α	=		0.0	0.0	0.0	4.2	
Phi.cos α	=		5.5	5.5	5.5	4.8	
Hi	=		5.49	5.49	5.49	9.03	
Hi.n	=		38.44	38.44	38.44	63.19	178.50
Vi.n.X	=		(672.19)	(206.99)	189.92	547.61	
Mti.n	=		(35.23)	(35.23)	(35.23)	(31.30)	
Mt=Mti.n + Vi.n.X	=		(707.42)	(242.22)	154.70	516.51	(278.43)

Total forces at footing of Abutment

Ho	=	178.50	ton
Vo	=	1,285.73	ton
Mo	=	(278.43)	t.m

Total forces at pile head

Hi.n = Ho	178.50	ton
Vi.n = Vo	1,285.73	ton
Mt = Mo	(278.43)	t.m

mvh–1

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F3		Nos of sheet	
Station	: FW 28 + 22		Prepared by	

III.6.2 Case – II,Normal condition (LWL)

dxi = (dxi.cos α) – (dy + alpa.Xi).sin α)
dyi = (dxi.sin α) + (dy + alpa.Xi)cos α)

		Side sign	Row of pile (1) L/s (–)	(2) L/s (–)	(3) R/s (+)	(4) R/s (+)	total per row
		degree	< 0			> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			7.00	7.00	7.00	7.00	
α	degree		0.00	0.00	0.00	5.71	
cos α	degree		1.000	1.000	1.000	0.995	
sin α	degree		0.000	0.000	0.000	0.099	
K1	t.m		2,974	2,974	2,974	2,974	
K2	t.m/rad		2,528	2,528	2,528	2,528	
K3	t.m/rad		2,528	2,528	2,528	2,528	
K4	t.m		4,300	4,300	4,300	4,300	
Kv	t.m		18,404	18,404	18,404	18,404	
dx	m		0.00143507	0.00143507	0.00143507	0.00143507	
dy	m		0.00247034	0.00247034	0.00247034	0.00247034	
alpa	rad		(0.00011549)	(0.00011549)	(0.00011549)	(0.00011549)	
dxi = dx cos α – (dy + alpa.Xi).sin α							
dx.cos α	=		0.00144	0.00144	0.00144	0.00143	
dy	=		0.00247	0.00247	0.00247	0.00247	
alpa	=		(0.00012)	(0.00012)	(0.00012)	(0.00012)	
Alpa x Xi	=		0.00022	0.00007	(0.00007)	(0.00022)	
dy + Alpa x Xi	=		0.00269	0.00254	0.00240	0.00225	
(dy + alpa.Xi).sin α	=		0.00000	0.00000	0.00000	0.00022	
dxi	=		0.00144	0.00144	0.00144	0.00120	
dyi = dx sin α + (dy + alpa.Xi).cos α							
dx.sin α	=		0.0000000	0.0000000	0.0000000	0.0001428	
dy	=		0.0024703	0.0024703	0.0024703	0.0024703	
alpa	=		(0.0001155)	(0.0001155)	(0.0001155)	(0.0001155)	
Alpa x Xi	=		0.0002165	0.0000722	(0.0000722)	(0.0002165)	
dy + Alpa x Xi	=		0.0026869	0.0025425	0.0023982	0.0022538	
(dy + alpa.Xi).cos α	=		0.0026869	0.0025425	0.0023982	0.0022426	
dyi	=		0.0026869	0.0025425	0.0023982	0.0023854	
P ni=Kv.dyi			49.45	46.79	44.14	43.90	
K1.dxi	=		4.27	4.27	4.27	3.58	
K2.alpa	=		(0.29)	(0.29)	(0.29)	(0.29)	
P hi=K1.dxi–K2.alpa	=		4.56	4.56	4.56	3.87	
K3.dxi	=		3.63	3.63	3.63	3.04	
K4.alpa	=		(0.50)	(0.50)	(0.50)	(0.50)	
M ti=–K3.dxi+K4.alpa	=		(4.12)	(4.12)	(4.12)	(3.54)	(15.91)
Mti x n	=		(28.87)	(28.87)	(28.87)	(24.78)	(111.39)
Vi = Pni.cos α – Phi.sin α							
Pni.cos	=		49.45	46.79	44.14	43.68	
Phi.sin α	=		0.00	0.00	0.00	0.39	
Vi	=		49.45	46.79	44.14	43.30	
Vi.n	=		346.15	327.55	308.95	303.08	1,285.73
Hi= Pni.sin α + Phi.cos α							
Pni.sin α	=		0.0	0.0	0.0	4.4	
Phi.cos α	=		4.6	4.6	4.6	3.9	
Hi	=		4.56	4.56	4.56	8.22	
Hi.n	=		31.92	31.92	31.92	57.54	153.30
Vi.n.X	=		(649.02)	(204.72)	193.09	568.28	
Mti.n	=		(28.87)	(28.87)	(28.87)	(24.78)	
Mt=Mti.n + Vi.n.X	=		(677.89)	(233.59)	164.22	543.51	(203.76)

Total forces at footing of Abutment

Ho	=	153.30	ton
Vo	=	1,285.73	ton
Mo	=	(203.76)	t.m

Total forces at pile head

Hi.n = Ho	153.30	ton
Vi.n = Vo	1,285.73	ton
Mt = Mo	(203.76)	t.m

mvh-2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F3		Nos of sheet	
Station	: FW 28 + 22		Prepared by	

III.6.3 Case – III, Earthquake condition (HWL)

dxi = (dxi.cos α) – (dy + alpa.Xi).sin α)
dyi = (dxi.sin α) + (dy + alpa.Xi)cos α)

		Side sign	Row of pile (1) L/s (–)	(2) L/s (–)	(3) R/s (+)	(4) R/s (+)	total per row
		degree	< 0			> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			7.00	7.00	7.00	7.00	
α	degree		0.00	0.00	0.00	5.71	
cos α	degree		1.000	1.000	1.000	0.995	
sin α	degree		0.000	0.000	0.000	0.099	
K1	t.m		3,193	3,193	3,193	3,193	
K2	t.m/rad		3,035	3,035	3,035	3,035	
K3	t.m/rad		3,035	3,035	3,035	3,035	
K4	t.m		5,770	5,770	5,770	5,770	
Kv	t.m		27,605	27,605	27,605	27,605	
dx	m		0.00393714	0.00393714	0.00393714	0.00393714	
dy	m		0.00150261	0.00150261	0.00150261	0.00150261	
alpa	rad		(0.00022675)	(0.00022675)	(0.00022675)	(0.00022675)	
dxi = dx cos α – (dy + alpa.Xi).sin α							
dx.cos α	=		0.00394	0.00394	0.00394	0.00392	
dy	=		0.00150	0.00150	0.00150	0.00150	
alpa	=		(0.00023)	(0.00023)	(0.00023)	(0.00023)	
Alpa x Xi	=		0.00043	0.00014	(0.00014)	(0.00043)	
dy + Alpa x Xi	=		0.00193	0.00164	0.00136	0.00108	
(dy + alpa.Xi).sin α	=		0.00000	0.00000	0.00000	0.00011	
dxi	=		0.00394	0.00394	0.00394	0.00381	
dyi = dx sin α + (dy + alpa.Xi).cos α							
dx.sin α	=		0.0000000	0.0000000	0.0000000	0.0003917	
dy	=		0.0015026	0.0015026	0.0015026	0.0015026	
alpa	=		(0.0002268)	(0.0002268)	(0.0002268)	(0.0002268)	
Alpa x Xi	=		0.0004252	0.0001417	(0.0001417)	(0.0004252)	
dy + Alpa x Xi	=		0.0019278	0.0016443	0.0013609	0.0010775	
(dy + alpa.Xi).cos α	=		0.0019278	0.0016443	0.0013609	0.0010721	
dyi	=		0.0019278	0.0016443	0.0013609	0.0014638	
P ni=Kv.dyi			53.22	45.39	37.57	40.41	
K1.dxi	=		12.57	12.57	12.57	12.17	
K2.alpa	=		(0.69)	(0.69)	(0.69)	(0.69)	
P hi=K1.dxi–K2.alpa	=		13.26	13.26	13.26	12.85	
K3.dxi	=		11.95	11.95	11.95	11.56	
K4.alpa	=		(1.31)	(1.31)	(1.31)	(1.31)	
M ti=–K3.dxi+K4.alpa	=		(13.26)	(13.26)	(13.26)	(12.87)	(52.65)
Mti x n	=		(92.80)	(92.80)	(92.80)	(90.11)	(368.52)
Vi = Pni.cos α – Phi.sin α							
Pni.cos	=		53.22	45.39	37.57	40.21	
Phi.sin α	=		0.00	0.00	0.00	1.28	
Vi	=		53.22	45.39	37.57	38.93	
Vi.n	=		372.51	317.74	262.97	272.51	1,225.73
Hi= Pni.sin α + Phi.cos α							
Pni.sin α	=		0.0	0.0	0.0	4.0	
Phi.cos α	=		13.3	13.3	13.3	12.8	
Hi	=		13.26	13.26	13.26	16.81	
Hi.n	=		92.82	92.82	92.82	117.68	396.13
Vi.n.X	=		(698.46)	(198.59)	164.36	510.95	
Mti.n	=		(92.80)	(92.80)	(92.80)	(90.11)	
Mt=Mti.n + Vi.n.X	=		(791.26)	(291.39)	71.55	420.84	(590.26)

Total forces at footing of Abutment

Ho	=	396.13	ton
Vo	=	1,225.73	ton
Mo	=	(590.26)	t.m

Total forces at pile head

Hi.n = Ho	396.13	ton
Vi.n = Vo	1,225.73	ton
Mt = Mo	(590.26)	t.m

mvh-3

Project : Medan Flood Control Channel : Medan Flood Way Structure : Br – F3 Station : FW 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.6.4 Case – IV, Earthquake condition (LWL)

dxi = (dxi.cos α) – (dy + alpa.Xi).sin α)
dyi = (dxi.sin α) + (dy + alpa.Xi)cos α)

			Row of pile				
		Side	(1)	(2)	(3)	(4)	total
		sign	L/s	L/s	R/s	R/s	per
		degree	(–)	(–)	(+)	(+)	row
			< 0			> 0	
Xi	m		(1.875)	(0.625)	0.625	1.875	
n=nos pile/rows			7.00	7.00	7.00	7.00	
α	degree		0.00	0.00	0.00	5.71	
cos α	degree		1.000	1.000	1.000	0.995	
sin α	degree		0.000	0.000	0.000	0.099	
K1	t.m		3,193	3,193	3,193	3,193	
K2	t.m/rad		3,035	3,035	3,035	3,035	
K3	t.m/rad		3,035	3,035	3,035	3,035	
K4	t.m		5,770	5,770	5,770	5,770	
Kv	t.m		27,605	27,605	27,605	27,605	
dx	m		0.00368576	0.00368576	0.00368576	0.00368576	
dy	m		0.00150812	0.00150812	0.00150812	0.00150812	
alpa	rad		(0.00023196)	(0.00023196)	(0.00023196)	(0.00023196)	
dxi = dx cos α – (dy + alpa.Xi).sin α							
dx.cos α	=		0.00369	0.00369	0.00369	0.00367	
dy	=		0.00151	0.00151	0.00151	0.00151	
alpa	=		(0.00023)	(0.00023)	(0.00023)	(0.00023)	
Alpa x Xi	=		0.00043	0.00014	(0.00014)	(0.00043)	
dy + Alpa x Xi	=		0.00194	0.00165	0.00136	0.00107	
(dy + alpa.Xi).sin α	=		0.00000	0.00000	0.00000	0.00011	
dxi	=		0.00369	0.00369	0.00369	0.00356	
dyi = dx sin α + (dy + alpa.Xi).cos α							
dx.sin α	=		0.0000000	0.0000000	0.0000000	0.0003667	
dy	=		0.0015081	0.0015081	0.0015081	0.0015081	
alpa	=		(0.0002320)	(0.0002320)	(0.0002320)	(0.0002320)	
Alpa x Xi	=		0.0004349	0.0001450	(0.0001450)	(0.0004349)	
dy + Alpa x Xi	=		0.0019430	0.0016531	0.0013631	0.0010732	
(dy + alpa.Xi).cos α	=		0.0019430	0.0016531	0.0013631	0.0010679	
dyi	=		0.0019430	0.0016531	0.0013631	0.0014346	
P ni=Kv.dyi			53.64	45.63	37.63	39.60	
K1.dxi	=		11.77	11.77	11.77	11.37	
K2.alpa	=		(0.70)	(0.70)	(0.70)	(0.70)	
P hi=K1.dxi–K2.alpa	=		12.47	12.47	12.47	12.07	
K3.dxi	=		11.19	11.19	11.19	10.81	
K4.alpa	=		(1.34)	(1.34)	(1.34)	(1.34)	
M ti=–K3.dxi+K4.alpa	=		(12.52)	(12.52)	(12.52)	(12.15)	(49.72)
Mti x n	=		(87.67)	(87.67)	(87.67)	(85.02)	(348.03)
Vi = Pni.cos α – Phi.sin α							
Pni.cos	=		53.64	45.63	37.63	39.41	
Phi.sin α	=		0.00	0.00	0.00	1.20	
Vi	=		53.64	45.63	37.63	38.20	
Vi.n	=		375.46	319.44	263.41	267.43	1,225.73
Hi= Pni.sin α + Phi.cos α							
Pni.sin α	=		0.0	0.0	0.0	3.9	
Phi.cos α	=		12.5	12.5	12.5	12.0	
Hi	=		12.47	12.47	12.47	15.95	
Hi.n	=		87.31	87.31	87.31	111.67	373.60
Vi.n.X	=		(704.00)	(199.65)	164.63	501.43	
Mti.n	=		(87.67)	(87.67)	(87.67)	(85.02)	
Mt=Mti.n + Vi.n.X	=		(791.67)	(287.32)	76.96	416.41	(585.62)

Total forces at footing of Abutment			
Ho	=	373.60	ton
Vo	=	1,225.73	ton
Mo	=	(585.62)	t.m

Total forces at pile head		
Hi.n = Ho	373.60	ton
Vi.n = Vo	1,225.73	ton
Mt = Mo	(585.62)	t.m

mvh–4

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F 3 Station : Fw 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.7 Control stresses on pile

III.7.1 Normal Condition

High Water Level

Depth embedded of pile = 9.00 m

Axial load Vi = 51.210 ton
= 51,210 kg

Moment Mi = 5.030 t.m
= 503,000 kg.cm

diameter do = 40.00 cm precast prestressed pipe
outer radius ro = 20.00 cm

M' = Mx + Vi x ro
= 503,000 + 51,210 x 20.00
= 503,000 + 1,024,200
= 1,527,200 kg.cm

excentrisitas $e = \frac{Mx}{Vi}$

$= \frac{503,000 \text{ kg.cm}}{51,210 \text{ kg}}$

= 9.82 cm

concrete covering a' = 2.50 cm

t = 7.50 cm

Inner diameter d i = 40.00 – 15.00
= 25.00

inner radius ri = 12.50 cm

ro^2 = 400.00
ri^2 = 156.25
ro^2–ri^2 = 400.00 – 156.25
ro^2–ri^2 = 243.75 cm2

area of steel bar
As = 8 ø 16 --Ø 16
8.00 x 2.0106 = 16.08 cm2

As = 16.08 cm2

$Ys = \frac{\text{Area of bar.Y bar}}{\text{Area of bar}}$

$= \frac{16.08 \times 12.50}{16.08}$

$= \frac{201.06}{16.08}$

teg–n

$= 12.50 \text{ cm}$

$$n = \frac{2,100.000}{119.500}$$

$= 17.57$

$$p = \frac{\text{tot.A rea of steel bar}}{@pi.ro\text{^}2}$$

$$= \frac{16.08}{3.14 \times 400.00}$$

$$= \frac{16.08}{1.256.64}$$

$p = 0.01280$

$n.p = 17.57 \times 0.01280$

$= 1.54810$

$$alpa = \frac{ri}{ro} = \frac{12.50}{20.00} = 0.63$$

$e = 9.82 \text{ cm}$

$$\frac{e}{ro} = \frac{9.82}{20.00} = 0.4911$$

$$\frac{e}{ro} = \frac{pi/4 - (5/12 - 1/6.\cos\text{^}2\,pi)\sin pi.\cos pi + (n.@pi.p)/2.(ri/ro)\text{^}2}{\sin pi/3.(2 + \cos\text{^}2\,pi) - pi.\cos pi - n.@pi.p \cos pi}$$

trial value of pi ---->>>>

pi	=	112.1361 degree
pi	=	1.9571 rad.

$e = pi/4 - (5/12 - 1/6.\cos\text{^}2\,pi)\sin pi.\cos pi + (n.@pi.p)/2.(alpa)\text{^}2$

pi/4 = A	=	1.9571	:	4.00	=	0.49
n	=	17.57				
alpa	=	0.63 cm				
alpa^2	=	0.39 cm^2				
cos pi	=	(0.376808)				
Sin pi	=	0.926291				
Cos^2 pi	=	0.141984				
1/6.cos^2 pi	=	0.166667	x	0.141984	=	0.02366
(5/12 − 1/6.cos^2 pi)	=	0.416667	−	0.023664	=	0.393003
Sin pi cos pi	=	0.926291	x	(0.376808)	=	(0.35)
(5/12 − 1/6.cos^2 pi) x sin pi.cos pi = B	=	0.39300	x	(0.37681)	=	(0.14809)
(n.@pi.p)	=	1.55	x	3.14	=	4.86
(n.@pi.p)/2	=	4.86	:	2.00	=	2.43
(n.@pi.p)/2 x (alpa)^2 = C	=	2.43	x	0.39	=	0.95
sum A − B + C	=	0.49	−	(0.15) +	0.95	= 1.59

ro = sin pi/3.(2 + cos^2 pi)−pi.cos pi − n.@pi.p cos pi

teg−n

(Sin pi)/3	=	0.309				
(2 + cos^2 pi)	=	2.000	+	0.142	=	2.142
sin ø/3 x (2 + cos^2 pi)	=	0.309	x	2.142	=	0.661
pi.cos pi	=	1.957	x	(0.377)	=	(0.737)
n.@pi.p	=	1.548	x	3.142	=	4.864
n.@pi.p cos pi	=	4.864	x	(0.377)	=	(1.833)
					=	3.231

$$\frac{e}{ro} = \frac{1.59}{3.23}$$

$pi = 112.14 \text{ rad}$

$$\frac{e}{ro} = 0.4912 \qquad \frac{e}{ro} = 0.4911$$

$$C = \frac{1 - \cos pi}{2\sin\text{^}3\,pi/3 - pi\cos pi + \sin pi\cos\text{^}2\,pi + pi/4 - \sin pi.\cos pi/4 - \sin\text{^}3.pi.\cos pi/6 \; @pi.np.(alpa\text{^}2/2 - \cos pi)}$$

Cos pi	=	(0.377)				
sin pi	=	0.926				
sin^3 pi	=	0.795				
sin pi.cos pi	=	0.926	x	(0.377)	=	(0.349)
Cos ^ 2pi	=	0.142				
1 − cos pi	=	1.000	−	(0.377)	=	1.377
2.sin^3 pi	=	2.000	x	0.795	=	1.590
2.sin^3 pi/3 = A	=	1.590	:	3.000	=	0.530
pi.cos pi = B	=	1.957	x	(0.377)	=	(0.737)
sin pi.cos^2 pi = C	=	0.926	x	0.142	=	0.132
pi/4 = D	=	0.489			=	0.489
Cos pi/4	=	(0.377)	:	4.000	=	(0.094)
sin pi.cos pi/4 = E	=	0.926	x	(0.094)	=	(0.087)
(sin^3 pi.cos pi)	=	0.795	x	(0.377)	=	(0.299)
(sin^3 pi.cos pi)/6 = F	=	(0.299)	:	6.000	=	(0.050)
n.p	=	1.548				
@pi.np	=	3.142	x	1.548	=	4.864
alpa	=	0.625				
alpa^2	=	0.391				
alpa^2/2	=	0.391	:	2.000	=	0.195
alpa^2/2−cos pi	=	0.195	−	(0.377)	=	0.572
@pi.np x alpa^2/2	=	4.864	x	0.195	=	0.950
@pi.np x alpa^2/2−cos ø = G	=	0.950	−	(0.377)	=	1.327
sum = A − B + C + D − E − F + G					=	3.352

$$C = \frac{1 - \cos pi}{2\sin\text{^}3\,pi/3 - pi\cos pi + \sin pi\cos\text{^}2\,pi + pi/4 - \sin pi.\cos pi/4 - \sin\text{^}3.pi.\cos pi/6 \; @pi.np.(alpa\text{^}2/2 - \cos pi)}$$

$$C = \frac{1.376808}{3.352} = 0.41074$$

$$S = C \times \frac{alpa + \cos pi}{1 - \cos pi}$$

$$= 0.411 \times \frac{0.625 + (0.377)}{1.377}$$

$= 0.411 \times 0.180$

$= 0.074$

teg−n

M'	=	1,527,200	kg.cm			
ro	=	20.000	cm			

stres on concrete = fc

$$fc = \frac{M'}{ro^3} \times C$$

$$= \frac{1,527,200}{8,000} \times 0.411$$

$$= 190.900 \times 0.411$$

$$= 78.41 \text{ kg/cm2} < 170 \text{ kg/cm2}$$

stres on steel = fs

$$fs = \frac{M'}{ro^3} \times S \times n$$

$$= \frac{1,527,200}{8,000} \times 0.074 \times 18 \text{ kg/cm2}$$

$$= 190.900 \times 0.074 \times 18 \text{ kg/cm2}$$

$$= 248 \text{ kg/cm2}$$

teg-n

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F 3 Station : Fw 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.7 Control stresses on pile

III.7.2 Earthquake Condition

High Water Level

Depth embedded of pile		=	9.00 m					
Axial load	Vi	=	53.220 ton					
			53,220 kg					
Moment	Mi	=	13.260 t.m					
		=	1,326,000 kg.cm					
diameter	do	=	40.00 cm precast prestressed pipe					
outer radius	ro	=	20.00 cm					
	M'	=	Mx	+	Vi	x	ro	
		=	1,326,000	+	53,220	x	20.00	
		=	1,326,000	+	1,064,400			
		=	2,390,400		kg.cm			

$$\text{excentrisitas} \quad e = \frac{Mx}{Vi}$$

$$= \frac{1,326,000 \text{ kg.cm}}{53,220 \text{ kg}}$$

$$= 24.92 \text{ cm}$$

concrete covering	a'	=	2.50 cm		
	t	=	7.50 cm		
Inner diameter	d i	=	40.00	–	15.00
		=	25.00		
inner radius	ri	=	12.50 cm		
ro^2		=	400.00		
ri^2		=	156.25		
ro^2–ri^2		=	400.00	–	156.25
ro^2–ri^2		=	243.75 cm2		

area of steel bar

As = 8 ø 16 --Ø 16

8.00 x 2.0106 = 16.08 cm2

As = 16.08 cm2

$$Ys = \frac{\text{Area of bar.Y bar}}{\text{Area of bar}}$$

$$= \frac{16.08 \times 12.50}{16.08}$$

$$= \frac{201.06}{16.08}$$

teg-q

$= 12.50$ cm

$$n = \frac{2{,}100.000}{119.500}$$

$= 17.57$

$$p = \frac{\text{tot.A rea of steel bar}}{@pi.ro\,\hat{}\,2}$$

$$= \frac{16.08}{3.14 \times 400.00}$$

$$= \frac{16.08}{1{,}256.64}$$

$p = 0.01280$

$n.p = 17.57 \times 0.01280$

$= 1.54810$

$$alpa = \frac{ri}{ro} = \frac{12.50}{20.00} = 0.63$$

$e = 24.92$ cm

$$\frac{e}{ro} = \frac{24.92}{20.00} = 1.2458$$

$$\frac{e}{ro} = \frac{pi/4 - (5/12 - 1/6.\cos\hat{}2\,pi)\sin pi.\cos pi + (n.@pi.p)/2.(ri/ro)\hat{}2}{\sin pi/3.(2 + \cos\hat{}2\,pi) - pi.\cos pi - n.@pi.p\cos pi}$$

trial value of pi --->>>>

pi	=	93.9161 degree
pi	=	1.6391 rad.

e = pi/4 − (5/12 − 1/6.cos^2 pi)sin pi.cos pi + (n.@pi.p)/2.(alpa) ^2

pi/4 = A	=	1.6391	:	4.00	=	0.41
n	=	17.57				
alpa	=	0.63 cm				
alpa^2	=	0.39 cm^2				
cos pi	=	(0.068296)				
Sin pi	=	0.997665				
Cos^2 pi	=	0.004664				
1/6.cos^2 pi	=	0.166667	x	0.004664	=	0.00078
(5/12 − 1/6.cos^2 pi)	=	0.416667	−	0.000777	=	0.415889
Sin pi cos pi	=	0.997665	x	(0.068296)	=	(0.07)
(5/12 − 1/6.cos^2 pi) x sin pi.cos pi = B	=	0.41589	x	(0.06830)	=	(0.02840)
(n.@pi.p)	=	1.55	x	3.14	=	4.86
(n.@pi.p)/2	=	4.86	:	2.00	=	2.43
(n.@pi.p)/2 x (alpa)^2 = C	=	2.43	x	0.39	=	0.95
sum A − B + C	=	0.41	−	(0.03)	+ 0.95 =	1.39

ro = sin pi/3.(2 + cos^2 pi)−pi.cos pi − n.@pi.p cos pi

(Sin pi)/3	=	0.333				
(2 + cos^2 pi)	=	2.000	+	0.005	=	2.005
sin ø /3 x (2 + cos^2 pi)	=	0.333	x	2.005	=	0.667
pi.cos pi	=	1.639	x	(0.068)	=	(0.112)
n.@pi.p	=	1.548	x	3.142	=	4.864
n.@pi.p cos pi	=	4.864	x	(0.068)	=	(0.332)
					=	1.111

$$\frac{e}{ro} = \frac{1.39}{1.11}$$

$pi = 93.92$ rad

$$\frac{e}{ro} = 1.2497$$

$$\frac{e}{ro} = 1.2458$$

$$C = \frac{1 - \cos pi}{2\sin\hat{}3\,pi/3 - pi\cos pi + \sin pi\cos\hat{}2\,pi + pi/4 - \sin pi.\cos pi/4 - \sin\hat{}3.pi.\cos pi/6\ @pi.np.(alpa\hat{}2/2 - \cos pi)}$$

Cos pi	=	(0.068)				
sin pi	=	0.998				
sin^3 pi	=	0.993				
sin pi.cos pi	=	0.998	x	(0.068)	=	(0.068)
Cos ^ 2pi	=	0.005				
1 − cos pi	=	1.000	−	(0.068)	=	1.068
2.sin^3 pi	=	2.000	x	0.993	=	1.986
2.sin^3 pi/3 = A	=	1.986	:	3.000	=	0.662
pi.cos pi = B	=	1.639	x	(0.068)	=	(0.112)
sin pi.cos^2 pi = C	=	0.998	x	0.005	=	0.005
pi/4 = D	=	0.410			=	0.410
Cos pi/4	=	(0.068)	:	4.000	=	(0.017)
sin pi.cos pi/4 = E	=	0.998	x	(0.017)	=	(0.017)
(sin^3 pi.cos pi)	=	0.993	x	(0.068)	=	(0.068)
(sin^3 pi.cos pi)/6 = F	=	(0.068)	:	6.000	=	(0.011)
n.p	=	1.548				
@pi.np	=	3.142	x	1.548	=	4.864
alpa	=	0.625				
alpa^2	=	0.391				
alpa^2/2	=	0.391	:	2.000	=	0.195
alpa^2/2−cos pi	=	0.195	−	(0.068)	=	0.264
@pi.np x alpa^2/2	=	4.864	x	0.195	=	0.950
@pi.np x alpa^2/2−cos ø = G	=	0.950	−	(0.068)	=	1.018
sum = A − B + C + D − E − F + G					=	2.235

$$C = \frac{1 - \cos pi}{2\sin\hat{}3\,pi/3 - pi\cos pi + \sin pi\cos\hat{}2\,pi + pi/4 - \sin pi.\cos pi/4 - \sin\hat{}3.pi.\cos pi/6\ @pi.np.(alpa\hat{}2/2 - \cos pi)}$$

$$C = \frac{1.068296}{2.235} = 0.47800$$

$$S = C \times \frac{alpa + \cos pi}{1 - \cos pi}$$

$$= 0.478 \times \frac{0.625 + (0.068)}{1.068}$$

$= 0.478 \times 0.521$

$= 0.249$

M'	=	2,390,400	kg.cm
ro	=	20.000	cm

stres on concrete = fc

$$fc = \frac{M'}{ro^3} \times C$$

$$= \frac{2,390,400}{8,000} \times 0.478$$

$$= 298.800 \times 0.478$$

$$= 142.83 \text{ kg/cm2} < 170 \text{ kg/cm2}$$

stres on steel = fs

$$fs = \frac{M'}{ro^3} \times S \times n$$

$$= \frac{2,390,400}{8,000} \times 0.249 \times 18 \text{ kg/cm2}$$

$$= 298.800 \times 0.249 \times 18 \text{ kg/cm2}$$

$$= 1,308 \text{ kg/cm2}$$

teg-q

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br – F 3 Station : Fw 28 + 22	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

III.8 Combined load at Abutment section

III.8.1 Case – I , Normal Condition (HWL)

Ka	=	0.297		Ywet	=	1.850	t/m3
Ht	=	7.300	m	Ysat	=	2.000	t/m3
Yw	=	1.000	t/m3	q	=	1.000	t/m2
Yc	=	2.400	t/m3				

Description	Total load (ton)					
	Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
Total	575.08	31.64	264.38	18.60	889.70	12.00
per Abt.	287.54	15.82	132.1	9.3	444.85	
per m'	23.962	1.318	11.016	0.775	37.071	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description							Vo	Ho	Xo	Yo	M = Vo.Yo
		Y	x	Hn	x	Wn	=	Weight					
		m		m		t/m3		ton	ton	ton	m	m	m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400				
		q	x	H									
Pq	=	1.00	x	1.945			=	1.945		1.945		0.973	1.892
Pa1		0.5 x Y	x	H1^2	x	Ka							
	=	0.5 x 1.85	x	3.78	x	0.297	=	1.039		1.039		0.648	
total									1.400	2.984			1.892

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m	
H4	=	0.500 m	W4	=	0.55 m	
H5	=	0.500 m	W5	=	0.55 m	

Load		Description							Vo	Ho	Xo	Yo	M = Vo.Yo
		Ye	x	H	x	W	=	Weight					
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400		0.150		0.210
C2	=	2.40	x	0.500	x	0.55	=	0.660	0.660		0.275		0.182
C3	=	0.5 x 2.40	x	0.500	x	0.55	=	0.330	0.330		0.275		0.091
E1	=	q	x	H	x	W							
	=	1.00	x	1.945	x	0.25	=	0.486	0.486		0.275		0.134
total									2.877				0.616

Section 3 – 3 Pe = 0.000 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.250 m	W7	=	0.200 m			

mqh-1

Load		W	Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M
			m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400				
C4	=		2.40	x	0.500	x	1.00	=	1.200	1.200				
C5	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=		2.40	x	1.000	x	0.55	=	1.320	1.320				
C6	=		2.40	x	0.500	x	0.20	=	0.240	0.240				
C7	=	0.5 x	2.40	x	0.250	x	0.20	=	0.060	0.060				
Pe								=	0.000		0.000		1.00	0.000
Pq	=		1.00	x	2.445			=	2.445		2.445		1.223	2.989
Pa	=	0.5 x	1.85	x	2.445	x	0.297	=	0.672		0.672		0.815	0.547
Rv	=								37.071	37.071				
		sum								41.621	3.117			3.536

Section 4 – 4

Top deck e = 38.700 m
Hwl elv. = 31.820 m
H back fill = Ht – H3
= 7.30 – 1.00 = 6.30 m
Top footing elv.
Elv. = 38.700 – 6.300 = 32.400 m
H wet soil = 38.70 – 32.40 = 6.30 m
H sat soil = 6.30 – 6.30 = 0.00 m

H1	=	1.945	m	W1	=	0.300 m
H2	=	4.355	m	W2	=	1.000 m
H4	=	0.500	m	W4	=	0.550 m
H5	=	0.500	m	W5	=	0.550 m
H6	=	0.500	m	W6	=	0.200 m
H7	=	0.250	m	W7	=	0.200 m

H wet = 6.30 : 3.00 + 0.00 = 2.10 m

mqh-1

Load		Description Y	x	Hn	x	Wn		Weight	Vo	Ho	Xo	Yo	M = Ho.Yo
		m		m		m		ton	ton	ton	m	m	t.m
C1	=	2.40	x	1.95	x	0.30	=	1.400	1.400				
C4	=	2.40	x	0.50	x	1.00	=	1.200	1.200				
C5	= 0.5 x	2.40	x	0.50	x	0.55	=	0.330	0.330				
C2	=	2.40	x	4.36	x	0.55	=	5.749	5.749				
C6	=	2.40	x	0.50	x	0.20	=	0.240	0.240				
C7	= 0.5 x	2.40	x	0.25	x	0.20	=	0.060	0.060				
Pe							=	0.000		0.000		4.355	0.000
Pq1	=	1.00	x	6.30			=	6.300		6.300		3.150	19.845
Pw1	= 0.5 x	1.85	x	39.690	x	0.297	=	10.904		10.904		2.100	22.898
Ps1	= 0.5 x	2.00	x	0.00	x	0.297	=	0.000		0.000		0.000	0.000
Ps2		2.00	x	0.00	x	0.297	=	0.000		0.000		0.000	0.000
Pwl	= 0.5 x	1.00	x	0.090			=	0.045		0.045		0.100	0.005
Pwr	= 0.5 x	1.00	x	0.00			=	0.000		0.000		0.000	0.000
Rv	=							37.071	37.071				
	sum								46.050	17.249			42.748

Section 5 – 5

H1 = 0.300 m W1 = 1.80 m
H2 = 1.000 m W2 = 1.80 m
H wet.r = 6.300 – 1.945 = 4.35 m
H sat.r = 0.000 m

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	= 0.5 x	2.40	x	0.30	x	1.80	=	0.648	0.648		0.600		0.389
C2	=	2.40	x	1.00	x	1.80	=	4.320	4.320		0.900		3.888
E1(wet)	=	1.85	x	4.35	x	1.80	=	14.502	14.502		0.900		13.052
E1(sat)	=	2.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
U1(up lift)	=	1.00	x	0.000	x	1.80	=	(0.000)	(0.000)		0.900		(0.000)
Rp 4							=	(41.740)	(41.740)		1.175		(49.045)
Rp 3							=	(43.410)	(43.410)		0.000		0.000
	total						=		(65.680)				(31.716)

Section 6 – 6

H 3.1 = 0.300 m W1 = 2.30 m
H 3.2 = 1.000 m W2 = 2.30 m
H wet = 6.300 m
H sat = 0.000 m

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C 3.1	= 0.5 x	2.40	x	0.300	x	2.30	=	0.828	0.828		0.767		0.635
C 3.2	=	2.40	x	1.000	x	2.30	=	5.520	5.520		1.150		6.348
E1(wet)	=	1.85	x	6.300	x	2.30	=	26.806	26.806		1.150		30.827
E1(sat)	=	2.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
U1(up lift)	=	1.00	x	0.000	x	2.30	=	(0.000)	(0.000)		1.150		(0.000)
Rp 1							=	(51.210)	(51.210)		1.675		(85.777)
Rp 2							=	(47.310)	(47.310)		0.425		(20.107)
	total						=		(65.366)				(68.073)

mqh-1

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel: Medan Flood Way		Date	
Structur: Br – P3		Nos of sheet	
Station : FW 28 + 22 m		Prepared by	

III.8.2 Case – II , Normal Condition (LWL)

Ka	=	0.297	Ywet	=	1.850	t/m3
Ht	=	7.300 m	Ysat	=	2.000	t/m3
Yw	=	1.000 t/m3	q	=	1.000	t/m2
Yc	=	2.400 t/m3				

Description	Total load (ton)					
	Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
Total	575.08	31.64	264.38	18.60	889.70	12.00
per Abt.	287.54	15.82	132.1	9.3	444.85	
per m'	23.962	1.318	11.016	0.775	37.071	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description								Vo	Ho	Xo	Yo	M = Vo.Yo
		Y	x	Hn	x	Wn	=	Weight						
		m		m		t/m3		ton		ton	ton	m	m	m
C1	=	2.40	x	1.945	x	0.30	=	1.400		1.400				
		q	x	H										
Pq	=	1.00	x	1.945			=	1.945			1.945		0.973	1.892
Pa1		0.5 x	Y	x	H1^2	x	Ka							
	=	0.5 x	1.85	x	3.78	x	0.297	=	1.039		1.039		0.648	
		total								1.400	2.984			1.892

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description								Vo	Ho	Xo	Yo	M = Vo.Yo
		Yc	x	H	x	W	=	Weight						
		m		m		t/m3		ton		ton	ton	m	m	t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400		1.400		0.150		0.210
C2	=	2.40	x	0.500	x	0.55	=	0.660		0.660		0.275		0.182
C3	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330		0.275		0.091
E1	=	q	x	H	x	W								
	=	1.00	x	1.945	x	0.25	=	0.486		0.486		0.275		0.134
		total								2.877				0.616

Section 3 – 3 Pe = 0.000 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.250 m	W7	=	0.200 m			

Load		W		Description						Vo	Ho	Xo	Yo	M
		Y	x	H	x	W	=	Weight						
		m		m		t/m3		ton		ton	ton	m	m	t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400		1.400				
C4	=	2.40	x	0.500	x	1.00	=	1.200		1.200				
C5	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=	2.40	x	1.000	x	0.55	=	1.320		1.320				
C6	=	2.40	x	0.500	x	0.20	=	0.240		0.240				
C7	=	0.5 x	2.40	x	0.250	x	0.20	=	0.060	0.060				
Pe								=	0.000		0.000		1.00	0.000
Pq	=	1.00	x	2.445				=	2.445		2.445		1.223	2.989
Pa	=	0.5 x	1.85	x	2.445	x	0.297	=	0.672		0.672		0.815	0.547
Rv	=								37.071	37.071				
		sum								41.621	3.117			3.536

Section 4 – 4

Top deck	=	38.700 m				
Lwl elv.	=	28.020 m				
H back fi	=	Ht	–	H3		
	=	7.30	–	1.00	=	6.30 m
Top footing elv.						
Elv	=	38.700	–	6.300	=	32.400 m
H wet soi	=	38.70	–	32.40	=	6.30 m
H sat soil	=	6.30	–	6.30	=	0.00 m

H1	=	1.945 m	W1	=	0.300 m
H2	=	4.355 m	W2	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m
H5	=	0.500 m	W5	=	0.550 m
H6	=	0.500 m	W6	=	0.200 m
H7	=	0.250 m	W7	=	0.200 m

H wet = 6.30 : 3.00 + 0.00 = 2.10 m

Load		Description								Vo	Ho	Xo	Yo	M = Ho.Yo
		Y	x	Hn	x	Wn		Weight						
		m		m		m		ton		ton	ton	m	m	t.m
C1	=	2.40	x	1.95	x	0.30	=	1.400		1.400				
C4	=	2.40	x	0.50	x	1.00	=	1.200		1.200				
C5	=	0.5 x	2.40	x	0.50	x	0.55	=	0.330	0.330				
C2	=	2.40	x	4.36	x	0.55	=	5.749		5.749				
C6	=	2.40	x	0.50	x	0.20	=	0.240		0.240				
C7	=	0.5 x	2.40	x	0.25	x	0.20	=	0.060	0.060				
Pe								=	0.000		0.000		4.355	0.000
Pq1	=	1.00	x	6.30				=	6.300		6.300		3.150	19.845
Pw1	=	0.5 x	1.85	x	39.690	x	0.297	=	10.904		10.904		2.100	22.898
Ps1	=	0.5 x	2.00	x	0.00	x	0.297	=	0.000		0.000		0.000	0.000
Ps2			2.00	x	0.00	x	0.297	=	0.000		0.000		0.000	0.000
Pwl	=	0.5 x	1.00	x	0.090			=	0.045		0.045		0.100	0.005
Pwr	=	0.5 x	1.00	x	0.00			=	0.000		0.000		0.000	0.000
Rv	=								37.071	37.071				
		sum								46.050	17.249			42.748

Section 5 – 5

H1	=	0.300 m	W1	=	1.80 m
H2	=	1.000 m	W2	=	1.80 m
H wet.r	=	6.300 –	1.945	=	4.35 m
H sat.r	=	0.000 m			

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	0.5 x	2.40	x	0.30	x	1.80	=	0.648	0.648		0.600		0.389
C2	=		2.40	x	1.00	x	1.80	=	4.320	4.320		0.900		3.888
E1(wet)	=		1.85	x	4.35	x	1.80	=	14.502	14.502		0.900		13.052
E1(sat)	=		2.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
U1(up lif	=		1.00	x	0.000	x	1.80	=	(0.000)	(0.000)		0.900		(0.000)
Rp 4								=	(43.300)	(43.300)		1.175		(50.878)
Rp 3								=	(44.140)	(44.140)		0.000		0.000
		total						=		(67.970)				(33.549)

Section 6 – 6

H 3.1	=	0.300 m	W1	=	2.30 m
H 3.2	=	1.000 m	W2	=	2.30 m
H wet	=	6.300 m			
H sat	=	0.000 m			

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C 3.1	=	0.5 x	2.40	x	0.300	x	2.30	=	0.828	0.828		0.767		0.635
C 3.2	=		2.40	x	1.000	x	2.30	=	5.520	5.520		1.150		6.348
E1(wet)	=		1.85	x	6.300	x	2.30	=	26.806	26.806		1.150		30.827
E1(sat)	=		2.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
U1(up lif	=		1.00	x	0.000	x	2.30	=	(0.000)	(0.000)		1.150		(0.000)
Rp 1								=	(49.450)	(49.450)		1.675		(82.829)
Rp 2								=	(46.790)	(46.790)		0.425		(19.886)
		total						=		(63.086)				(64.904)

mqh-2

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F3		Nos of sheet	
Station	: FW 28 + 22 m		Prepared by	

III.8.3 Case – III Earthquake condition (HWL)

Ka	=	0.407	Ywet	=	1.850 t/m3
Ht	=	7.300 m	Ysat	=	2.000 t/m3
Yw	=	1.000 t/m3	q	=	0.500 t/m2
Yc	=	2.400 t/m3			

Description	Total load (ton) Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
Total	575.08	31.64	264.38	18.60	889.70	12.00
per Abt.	287.54	15.82	132.1	9.3	444.85	
per m'	23.962	1.318	11.016	0.775	37.071	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description Y	x	Hn	x	Wn	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Yo
		m		m		t/m3		ton	ton	ton	m	m	m
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400				
		q	x	H									
Pq	=		0.50	x	1.945			=	0.973		0.973		0.973	0.946
Pa1		0.5 x	Y	x	H1^2	x	Ka							
	=	0.5 x	1.85	x	3.78	x	0.407	=	1.424		1.424		0.648	
		total								1.400	2.397			0.946

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description Yc	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Yo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=		2.40	x	1.945	x	0.30	=	1.400	1.400		0.150		0.210
C2	=		2.40	x	0.500	x	0.55	=	0.660	0.660		0.275		0.182
C3	=	0.5 x	2.40	x	0.500	x	0.55	=	0.330	0.330		0.275		0.091
E1	=		q	x	H	x	W							
	=		0.50	x	1.945	x	0.25	=	0.243	0.243		0.275		0.067
		total								2.634				0.549

Section 3 – 3 Pe = 3.398 ton (by earthquake)

H1	=	1.945 m	W1	=	0.300 m	H1 + H4	=	2.445 m
H2	=	1.000 m	W2	=	1.000 m	He=H4+H5	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m			
H5	=	0.500 m	W5	=	0.550 m			
H6	=	0.500 m	W6	=	0.200 m			
H7	=	0.250 m	W7	=	0.200 m			

mqh-3

Load		W Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=			2.40	x	1.945	x	0.30	=	1.400	1.400				
C4	=			2.40	x	0.500	x	1.00	=	1.200	1.200				
C5	=	0.5	x	2.40	x	0.500	x	0.55	=	0.330	0.330				
C2	=			2.40	x	1.000	x	0.55	=	1.320	1.320				
C6	=			2.40	x	0.500	x	0.20	=	0.240	0.240				
C7	=	0.5	x	2.40	x	0.250	x	0.20	=	0.060	0.060				
Pe									=	3.398		3.398		1.00	3.398
Pq	=			0.50	x	2.445			=	1.223		1.223		1.223	1.495
Pa	=	0.5	x	1.85	x	2.445	x	0.407	=	0.920		0.920		0.815	0.750
Rv	=									37.071	37.071				
		sum									41.621	5.541			5.643

Section 4 – 4

Top deck elv = 38.700 m
Hwl elv. = 31.820 m
H back fill = Ht – H3
= 7.30 – 1.00 = 6.30 m

Top footing elv.
Elv = 38.700 – 6.300 = 32.400 m
H wet soil = 38.70 – 32.40 = 6.30 m
H sat soil = 6.30 – 6.30 = 0.00 m

H1	=	1.945 m	W1	=	0.300 m
H2	=	4.355 m	W2	=	1.000 m
H4	=	0.500 m	W4	=	0.550 m
H5	=	0.500 m	W5	=	0.550 m
H6	=	0.500 m	W6	=	0.200 m
H7	=	0.250 m	W7	=	0.200 m

H wet = 6.30 : 3.00 + 0.00 = 2.10 m

Load		Description Y	x	Hn	x	Wn	Weight	Vo	Ho	Xo	Yo	M = Ho.Yo
		m		m		m	ton	ton	ton	m	m	t.m
C1	=			2.40	x	1.95	x 0.30 =	1.400	1.400				
C4	=			2.40	x	0.50	x 1.00 =	1.200	1.200				
C5	=	0.5	x	2.40	x	0.50	x 0.55 =	0.330	0.330				
C2	=			2.40	x	4.36	x 0.55 =	5.749	5.749				
C6	=			2.40	x	0.50	x 0.20 =	0.240	0.240				
C7	=	0.5	x	2.40	x	0.25	x 0.20 =	0.060	0.060				
Pe							=	3.398		3.398		4.355	14.798
Pq1	=			0.50	x	6.30	=	3.150		3.150		3.150	9.923
Pwt	=	0.5	x	1.85	x	39.690	x 0.407 =	14.942		14.942		2.100	31.379
Ps1	=	0.5	x	2.00	x	0.00	x 0.407 =	0.000		0.000		0.000	0.000
Ps2				2.00	x	0.00	x 0.407 =	0.000		0.000		0.000	0.000
Pwl	=	0.5	x	1.00	x	0.090	=	0.045		0.045		0.100	0.005
Pwr	=	0.5	x	1.00	x	0.00	=	0.000		0.000		0.000	0.000
Rv	=							37.071	37.071				
		sum							46.050	21.535			56.104

Section 5 – 5

H1 = 0.300 m W1 = 1.80 m
H2 = 1.000 m W2 = 1.80 m
H wet.r = 6.300 – 1.945 = 4.35 m
H sat.r = 0.000 m

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C1	=	0.5	x	2.40	x	0.30	x	1.80	= 0.648	0.648		0.600		0.389
C2	=			2.40	x	1.00	x	1.80	= 4.320	4.320		0.900		3.888
E1(wet)	=			1.85	x	4.35	x	1.80	= 14.502	14.502		0.900		13.052
E1(sat)	=			2.00	x	0.000	x	1.80	= 0.000	0.000		0.900		0.000
U1(up lift)	=			1.00	x	0.000	x	1.80	= (0.000)	(0.000)		0.900		(0.000
Rp 4									= (38.930)	(38.930)		1.175		(45.743
Rp 3									= (37.570)	(37.570)		0.000		0.000
				total					=	(57.030)				(28.414

Section 6 – 6

H 3.1 = 0.300 m W1 = 2.30 m
H 3.2 = 1.000 m W2 = 2.30 m
H wet = 6.300 m
H sat = 0.000 m

Load		Description Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	M = Vo.Xo
		m		m		t/m3		ton	ton	ton	m	m	t.m
C 3.1	=	0.5	x	2.40	x	0.300	x	2.30	= 0.828	0.828		0.767		0.635
C 3.2	=			2.40	x	1.000	x	2.30	= 5.520	5.520		1.150		6.348
E1(wet)	=			1.85	x	6.300	x	2.30	= 26.806	26.806		1.150		30.827
E1(sat)	=			2.00	x	0.000	x	2.30	= 0.000	0.000		1.150		0.000
U1(up lift)	=			1.00	x	0.000	x	2.30	= (0.000)	(0.000)		1.150		(0.000
Rp 1									= (53.220)	(53.220)		1.675		(89.143
Rp 2									= (45.390)	(45.390)		0.425		(19.291
				total					=	(65.456)				(70.624

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel : Medan Flood Way		Date	
Structure: Br – F3		Nos of sheet	
Station : FW 28 + 22 m		Prepared by	

III.8.4 Case – IV , Earthquake condition (LWL)

Ka	=	0.407		Ywet	=	1.850	t/m3
Ht	=	7.300	m	Ysat	=	2.000	t/m3
Yw	=	1.000	t/m3	q	=	0.500	t/m2
Yc	=	2.400	t/m3				

Description	Total load (ton)					
	Dead load	Line load	Uniform load	Pedestrian load	Total load	Width
Total	575.08	31.64	264.38	18.60	889.70	12.00
per Abt.	287.54	15.82	132.1	9.3	444.85	
per m'	23.962	1.318	11.016	0.775	37.071	

Section 1 – 1 H1 = 1.945 m W1 = 0.300 m

Load		Description												M = Vo.Yo
		Y	x	Hn	x	Wn	=	Weight	Vo	Ho	Xo	Yo		
		m		m		t/m3		ton	ton	ton	m	m		m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400					
		q	x	H										
Pq	=	0.50	x	1.945			=	0.973		0.973		0.973		0.946
Pa1		0.5	x	Y	x	H1^2	x	Ka						
	=	0.5	x	1.85	x	3.78	x	0.407	=	1.424		1.424		0.648
		total								1.400		2.397		0.946

Section 2 – 2

H1	=	1.945 m	W1	=	0.30 m
H4	=	0.500 m	W4	=	0.55 m
H5	=	0.500 m	W5	=	0.55 m

Load		Description												M = Vo.Yo
		Yc	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo		
		m		m		t/m3		ton	ton	ton	m	m		t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400	1.400		0.150			0.210
C2	=	2.40	x	0.500	x	0.55	=	0.660	0.660		0.275			0.182
C3	=	0.5	x	2.40	x	0.500	x	0.55	=	0.330	0.330		0.275	0.091
E1	=	q	x	H	x	W								
	=	0.50	x	1.945	x	0.25	=	0.243	0.243		0.275			0.067
		total							2.634					0.549

Section 3 – 3 Pe = 3.398 ton (by earthquake)

H1	=	1.945	m	W1	=	0.300	m	H1 + H4	=	2.445 m
H2	=	1.000	m	W2	=	1.000	m	He=H4+H5	=	1.000 m
H4	=	0.500	m	W4	=	0.550	m			
H5	=	0.500	m	W5	=	0.550	m			
H6	=	0.500	m	W6	=	0.200	m			
H7	=	0.250	m	W7	=	0.200	m			

Load		W	Description							Vo	Ho	Xo	Yo	M
		Y	x	H	x	W	=	Weight						
		m		m		t/m3		ton		ton	ton	m	m	t.m
C1	=	2.40	x	1.945	x	0.30	=	1.400		1.400				
C4	=	2.40	x	0.500	x	1.00	=	1.200		1.200				
C5	=	0.5	x	2.40	x	0.500	x	0.55	=	0.330		0.330		
C2	=	2.40	x	1.000	x	0.55	=	1.320		1.320				
C6	=	2.40	x	0.500	x	0.20	=	0.240		0.240				
C7	=	0.5	x	2.40	x	0.250	x	0.20	=	0.060		0.060		
Pe								=		3.398		3.398		1.00		3.398
Pq	=	0.50	x	2.445				=		1.223		1.223		1.223		1.495
Pa	=	0.5	x	1.85	x	2.445	x	0.407	=	0.920		0.920		0.815		0.750
Rv	=									37.071		37.071				
		sum								41.621		5.541				5.643

Section 4 – 4

Top deck e = 38.700 m
Lwl elv. = 28.020 m
H back fill = Ht – H3
= 7.30 – 1.00 = 6.30 m
Top footing elv.
Elv = 38.700 – 6.300 = 32.400 m
H wet soil = 38.70 – 32.40 = 6.30 m
H sat soil = 6.30 – 6.30 = 0.00 m

H1	= 1.945 m	W1	=	0.300 m	
H2	= 4.355 m	W2	=	1.000 m	
H4	= 0.500 m	W4	=	0.550 m	
H5	= 0.500 m	W5	=	0.550 m	
H6	= 0.500 m	W6	=	0.200 m	
H7	= 0.250 m	W7	=	0.200 m	
H wet	= 6.30 :	3.00 +	0.00	=	2.10 m

Load		Description								Vo	Ho	Xo	Yo	M = Ho.Yo
		Y	x	Hn	x	Wn		Weight						
		m		m		m		ton		ton	ton	m	m	t.m
C1	=	2.40	x	1.95	x	0.30	=	1.400		1.400				
C4	=	2.40	x	0.50	x	1.00	=	1.200		1.200				
C5	=	0.5	x	2.40	x	0.50	x	0.55	=	0.330		0.330		
C2	=	2.40	x	4.36	x	0.55	=	5.749		5.749				
C6	=	2.40	x	0.50	x	0.20	=	0.240		0.240				
C7	=	0.5	x	2.40	x	0.25	x	0.20	=	0.060		0.060		
Pe								=		3.398		3.398		4.355		14.798
Pq1	=	0.50	x	6.30				=		3.150		3.150		3.150		9.923
Pw1	=	0.5	x	1.85	x	39.690	x	0.407	=	14.942		14.942		2.100		31.379
Ps1	=	0.5	x	2.00	x	0.00	x	0.407	=	0.000		0.000		0.000		0.000
Ps2		2.00	x	0.00	x	0.407	=	0.000		0.000		0.000		0.000		0.000
Pwl	=	0.5	x	1.00	x	0.090		=		0.045		0.045		0.100		0.005
Pwr	=	0.5	x	1.00	x	0.00		=		0.000		0.000		0.000		0.000
Rv	=									37.071		37.071				
		sum								46.050		21.535				56.104

Section 5 – 5

H1	=	0.300 m	W1	=	1.80 m
H2	=	1.000 m	W2	=	1.80 m
H wet.r	=	6.300 –	1.945	=	4.35 m
H sat.r	=	0.000 m			

Load	Description													M = Vo.Xo
		Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	
		m		m		t/m3		ton	ton	ton	m	m		t.m
C1	=	0.5	x	2.40	x	0.30	x	1.80	=	0.648	0.648		0.600		0.389
C2	=			2.40	x	1.00	x	1.80	=	4.320	4.320		0.900		3.888
E1(wet)	=			1.85	x	4.35	x	1.80	=	14.502	14.502		0.900		13.052
E1(sat)	=			2.00	x	0.000	x	1.80	=	0.000	0.000		0.900		0.000
U1(up lift)	=			1.00	x	0.000	x	1.80	=	(0.000)	(0.000)		0.900		(0.000)
Rp 4									=	(38.200)	(38.200)		1.175		(44.885)
Rp 3									=	(37.630)	(37.630)		0.000		0.000
				total					=		(56.360)				(27.556)

Section 6 – 6

H 3.1 = 0.300 m W1 = 2.30 m
H 3.2 = 1.000 m W2 = 2.30 m
H wet = 6.300 m
H sat = 0.000 m

Load	Description													M = Vo.Xo
		Y	x	H	x	W	=	Weight	Vo	Ho	Xo	Yo	
		m		m		t/m3		ton	ton	ton	m	m		t.m
C 3.1	=	0.5	x	2.40	x	0.300	x	2.30	=	0.828	0.828		0.767		0.635
C 3.2	=			2.40	x	1.000	x	2.30	=	5.520	5.520		1.150		6.348
E1(wet)	=			1.85	x	6.300	x	2.30	=	26.806	26.806		1.150		30.827
E1(sat)	=			2.00	x	0.000	x	2.30	=	0.000	0.000		1.150		0.000
U1(up lift)	=			1.00	x	0.000	x	2.30	=	(0.000)	(0.000)		1.150		(0.000)
Rp 1									=	(53.640)	(53.640)		1.675		(89.847)
Rp 2									=	(45.630)	(45.630)		0.425		(19.393)
				total					=		(66.116)				(71.429)

mqh–4

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Floodway		Date	
Structure	: Br – Mf 3		Nos of sheet	
Station	: Fw 28 + 22		Prepared by	

III.9 Resume forces on Abutment Section

Case – I,Normal Condition (HWL)

Case	Forces	Unit	Section 1	2	3	4	5	6
Case – I	Moment	t.m	1.892	0.616	3.536	42.748	31.716	68.073
		kg.cm	189,200	61,600	353,600	4,274,800	3,171,600	6,807,300
	Shear	ton	2.980	2.887	3.117	17.24	65.68	65.366
		kg	2,980	2,887	3,117	17,240	65,680	65,366
	Normal	ton	1.400	0.0	41.621	46.050	0.0	0.0
		kg	1,400	0.0	41,621	46,050	0.0	0.0

Case – II,Normal Condition (LWL)

Case	Forces	Unit	Section 1	2	3	4	5	6
Case – II	Moment	t.m	1.892	0.616	3.536	42.748	33.549	64.904
		kg.cm	189,200	61,600	353,600	4,274,800	3,354,900	6,490,400
	Shear	ton	2.984	2.877	3.117	17.24	67.97	63.086
		kg	2,984	2,877	3,117	17,240	67,970	63,086
	Normal	ton	1.400	0	41.621	46.05	0	0
		kg	1,400	0	41,621	46,050	0	0

Case – III,Earthquake Condition (HWL)

Case	Forces	Unit	Section 1	2	3	4	5	6
Case – III	Moment	t.m	0.946	0.549	5.645	56.104	28.414	70.624
		kg.cm	94,600	54,900	564,500	5,610,400	2,841,400	7,062,400
	Shear	ton	2.397	2.634	5.541	21.54	57.03	65.453
		kg	2,397	2,634	5,541	21,535	57,030	65,453
	Normal	ton	1.400	0	41.621	46.05	0	0
		kg	1,400	0	41,621	46,050	0	0

Case – IV,Earthquake Condition (LWL)

Case	Forces	Unit	Section 1	2	3	4	5	6
Case – IV	Moment	t.m	0.946	0.549	5.643	56.104	27.556	71.429
		kg.cm	94,600	54,900	564,300	5,610,400	2,755,600	7,142,900
	Shear	ton	2.40	2.634	5.541	21.535	56.36	66.116
		kg	2,400	2,634	5,541	21,535	56,360	66,116
	Normal	ton	1.40	0	41.621	46.05	0	0
		kg	1,400	0	41,621	46,050	0	0

mnh

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel : Medan Flood Way		Date	
Structure : Br – Mf 3		Nos of sheet	
Station : Fw 26 + 22		Prepared by	

III.10 Reinforcing steel bar of Abutment section
Section – 4

Item	Describtion	unit	Normal condition Calcu–lation	Earth quake condition Calcu–lation
	Allowance stresses			
concrete compressive	fc = K – 225	kg/cm2	*75*	*75*
steel tensile	fs	kg/cm2	*1400*	*1400*
concrete shear	tou without r.bar	kg/cm2	*8*	*8*
	tou with r.bar	kg/cm2	*20*	*20*
transformend	n = Es/Ec		*21*	*21*
Moment	M	t.m	42.748	56.104
		kg.cm	4,274,800	5,610,400
Shear	S	ton	65.68	21.54
		kg	65680	21540
Normal	N	ton	46.050	46.050
		kg	46,050	46,050
dimension	b	cm	*100*	*100*
	ht	cm	*100*	*100*
	d'	cm	*10*	*10*
	h	cm	*90*	*90*
	b.h	cm2	*9,000*	*9,000*
Calculation for reinfor–cement bar with steel full working	eo1=M/N	cm	92.83	121.83
	eo2=1/30.ht,> 2 cm	cm	3.33	3.33
	used eo2	cm	2.00	2.00
	eo=eo1+eo2	cm	94.83	123.83
	eo/ht (see table)		0.95	1.24
	C		7.70	7.70
	lk	cm	435.3	435.3
	100.ht	cm	10,000	10,000
	lk/100.ht	cm	0.0435	0.0435
	(lk/100.ht) ^ 2	cm	*0.0019*	*0.0019*
	e1=C.[lk/(100.ht)] ^ 2.ht	cm	*1.459*	*1.459*
	e2=0.15.ht	cm	*15.00*	*15.00*
	e=eo+e1+e2	cm	*111.29*	*140.29*
	ea=e+1/2.ht–d'	cm	151.29	180.29
	M' = N.ea	kg.cm	6,966,839	8,302,439
	n.M'	kg.cm	146,303,617	174,351,217
	b.fs	kg/cm	140,000	140,000
	n.M'/(b.fs)		1,045.03	1,245.37
	@sqrt(n.M'/(b.fs))		32.33	35.29
	Ca=h /@sqrt(n.M'/b.fs) see PBI 1971 N.I–2		*2.784*	*2.550*
	n.fc		1,575	1,575
	øo = fs / (n.fc)		0.8889	0.8889
	delta		0.60	0.60
	from table fined Ca		2.783	2.554
	fine ø > øo		1.703	1.564
	ø'		2.333	2.103
	ksi(j)		0.370	0.390
	zeta		0.883	0.879
	100 nw		14.63	17.44
	nw		0.1463	0.1744
	w		0.00697	0.00830
	ea/h		1.68	2.00
	from table fined I		2.07	1.760
	i.A = wbh		62.70	74.74
	A	cm2	30.29	41.99
	A' =delta.	cm2	37.620	44.846

A – used bar dia. 25 mm @ 12.5 cm,

=	1.327			Area @ bar =	4.900
=	10			nos of bar =	10
=	10	x	1.327	total area =	10 x 4.900
=	13.27 cm >		30.29 cm2	(cm2) =	49.00 cm2 > 37.62

	steel bar full warking		
	n.ø		35.76
tension of bar	fs	kg/cm2	1,400.00
compressive concrete	fc' = fs / (n.ø)	kg/cm2	39.15
tensile of bar	fs' = fs / ø'	kg/cm2	600.09
	7/8.b.h	cm2	7,875.00
shear concrete	Tca = S / (7/8.b.h)	kg/cm2	8.34

Section – 5

Item	Describtion	unit	Normal condition Calcu–lation	Earth quake condition Calcu–lation
	Allowance stresses			
concrete compressive	fc = K – 225	kg/cm2	*75*	*75*
steel tensile	fs	kg/cm2	*1400*	*1400*
concrete shear	tou without r.bar	kg/cm2	*8*	*8*
	tou with r.bar	kg/cm2	*20*	*20*
transformend	n = Es/Ec		*21*	*21*
Moment	M	t.m	68.073	70.624
		kg.cm	6,807,300	7,062,400
Shear	S	ton	60.966	71.429
		kg	65.366	71429
dimension	b	cm	*100*	*100*
	ht	cm	*1,300*	*1,300*
	d'	cm	*10*	*10*
	h	cm	*1,290*	*1,290*
	b.h	cm2	*129,000*	*129,000*
	M	kg.cm	6,807,300	7,062,400
	n.M	kg.cm	142,953,300	148,310,400
	b.fs	kg/cm	140,000	140,000
	n.M / (b.fs)		1,021.09	1,059.36
	@sqrt(n.M /(b.fs))		31.95	32.55
	Ca=h /@sqrt(n.M/b.fs) see PBI 1971 N.I–2		*40.370*	*39.634*
	n.fc		1,575	1,575
	øo = fs / (n.fc)		0.8889	0.8889
	delta		1.00	1.00
	from table fined Ca		12.290	12.290
Calculation for reinfor–cement bar with steel full working	fine ø > øo		8.091	8.091
	ø'		89.000	89.000
	ksi(j)		0.110	0.110
	zeta		0.963	0.963
	100 nw		0.688	0.688
	nw		0.00688	0.00688
	w		0.00033	0.00033
	A	cm2	42.26	42.26
	A' =delta.i.A	cm2	42.26	42.26

A – used bar dia. 25 mm @ 12.5 cm,

Area @ bar	=	4.900		Area @ bar =	4.900
nos of bar	=	10		nos of bar =	10
total area	=	10	x 4.9	total area =	10 x 4.900
(cm2)	=	49.00 cm >	42.26 cm2	(cm2) =	49 cm2 > 42.26

	steel bar full warking		
	n.ø		169.91
tension of bar	fs	kg/cm2	1,400.00
compressive concrete	fc' = fs / (n.ø)	kg/cm2	8.24
tensile of bar	fs' = fs / ø'	kg/cm2	15.73
	7/8.b.h	cm2	112,875.00
shear concrete	Tca = S / (7/8.b.h)	kg/cm2	0.00

bar

PRESTRESSED CONCRETE BRIDGE COMPUTATION
CHANNEL MEDAN FLOOD WAY
Br – Mf 1
Station : Fw 08 + 90

span
31.00

Width
7.0 m

II SUB STRUCTURE

Abutment

II.1 Neutral axis of Abutment
II.2 Earthquake coefficient
II.3 Axial forces on Abutment
II.4 Coulumb coefficient
II.5 Horizontal force
- II.5.1 Case – I,Normal condition (HWL)
- II.5.2 Case – II,Normal condition (LWL)
- II.5.3 Case – III,Earthquake condition (HWL)
- II.5.4 Case – IV,Earthquake condition (LWL)

II.6 Combined Load on Abutment
- II.6.1 Case – I,Normal condition (HWL)
- II.6.2 Case – II,Normal condition (LWL)
- II.6.3 Case – III,Earthquake condition (HWL)
- II.6.4 Case – IV,Earthquake condition (LWL)

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel : Medan Flood Way		Date
Structure: Br – F1		Nos of sheet
Station : Fw 06 + 90		Prepared by

II ABUTMENT

II.1 Neutral axis

depth of abutment		=	8.80	m							
depth beam		=	1.60	m							
depth slab		=	0.245	m							
depth of beam to deck		=	1.845	m							
depth of beam and deck		=	1.600	+	0.245	=	1.845	m			
depth bearing pad						=	0.100	m			
depth back wall		=	1.845	+	0.100	=	1.945	m			
depth of footing		=	1.000	m							
depth of steam		=	8.800	–	1.945	–	1.000	=	5.855	m	
	H1	=	1.945	m	W1	=	0.300	m			
	H2	=	5.855	m	Wf1	=	2.300	m			
	H3	=	1.000	m	Wf2	=	1.000	m			
	Ht	=	8.800	m	Wf3	=	1.800	m			
		=			W3	=	5.100	m			
Depth of back fill		=	8.800	–	1.000	=	7.800	m			
	H4	=	0.500	m	W4	=	0.550	m			
	H5	=	0.250	m	W5	=	0.550	m			
	H6	=	0.500	m	W6	=	0.200	m			
	H7	=	0.250	m	W7	=	0.200	m			
	H8	=	0.300	m	W8	=	0.300	m			
	H9	=	0.300	m	W9	=	1.800	m			

A1	W1	=	0.300	X1 =	W1/2	+	W2	+	Wf3					
					0.150	+	1.000	+	1.800			=	2.950	m
	H1	=	1.945	Y1=	Ht	–	H1/2							
					8.800	–	0.973					=	7.827	m
A2	W2	=	1.000	X2 =	W2/2	+	Wf3							
					0.500	+	1.800					=	2.300	m
	H2	=	5.855	Y2=	H2/2	+	H3							
					2.927	+	1.000					=	3.927	m
A3	W3	=	5.100	X3 =	W3/2									
					2.550							=	2.550	m
	H3	=	1.000	Y3=	H3/2									
					0.500							=	0.500	m
A4	W4	=	0.550	X4 =	W4/2	+	W2	+	Wf3					
					0.275	+	1.000	+	1.800			=	3.075	m
	H4	=	0.500	Y4=	H2	–	H4/2	+	H3					
					5.855	–	0.500	+	1.000			=	6.355	m
A5	W5	=	0.550	X5 =	W5/3	+	W2	+	Wf3					
					0.183	+	1.000	+	1.800			=	2.983	m
	H5	=	0.250	Y5=	H2	–	H4/2	–	H5/3	+	H3			
					5.855	–	0.250	–	0.083	+	1.000	=	6.522	m
A6	W6	=	0.200	X6 =	Wf3	–	W6/2							
					1.800	–	0.100					=	1.700	m
	H6	=	0.500	Y6=	H2	–	H6/2	+	H3					
					5.855	–	0.250	+	0.083			=	5.688	m
A7	W7	=	0.200	X7 =	Wf3	–	W7/3							
					1.800	–	0.067					=	1.733	m
	H7	=	0.250	Y7=	H2	–	H6/2	–	H7/3	+	H3			
					5.855	–	0.250	–	0.083	+	1.000	=	6.522	m
A8	W8	=	2.300	X8 =	W8/3	+	Wf2	+	Wf3					
					0.767	+	1.000	+	1.800			=	3.567	m
	H8	=	0.300	Y8=	H8/3	+	H3							
					0.100	+	1.000					=	1.100	m

x–y

A9	W9	=	1.800	X9 =	W9x2/3									
					1.200							=	1.200	m
	H9	=	0.300	Y9=	H9/3	+	H3							
					0.100	+	1.000					=	1.100	m

Wing wall

Hgw	=	1.200	m	H back fill	=	7.80	m
Ww1	=	3.00	m	Hw1	=	3.00	m
Ww2	=	2.30	m	Hw2	=	1.00	m
Ww3	=	0.70	m	Hw3	=	1.00	m
Ww4	=	2.30	m	Hw4	=	3.50	m
Ww5	=	2.30	m	Hw5	=	0.30	m

Ww1	Ww1	=	3.000	Xw1=	Ww1/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800			=	4.300	m
	Hw1	=	3.000	Yw1=	Ht	–	Hw1/2							
					8.800	–	1.500					=	7.300	m
Ww2	Ww2	=	2.300	Xw2=	Ww2/2	+	W2	+	Wf3					
					1.150	+	1.000	+	1.800			=	3.950	m
	Hw2	=	1.000	Yw2=	Ht	–	Hw1	–	Hw2/2					
					8.800	–	3.000	–	0.500			=	5.300	m
Ww3	Ww3	=	0.700	Xw3=	W3	–	Ww3/2							
					5.100	–	0.350					=	4.750	m
	Hw3	=	1.000	Yw3=	Ht	–	Hw1	–	Hw3/2					
					8.800	–	3.000	–	0.333			=	5.467	m
Ww4	Ww4	=	2.300	Xw4=	Ww4/2	+	W2	+	Wf3					
					1.150	+	1.000	+	1.800			=	3.950	m
	Hw4	=	3.500	Yw4=	Hw4/2	+	Hw5	+	H3					
					1.750	+	0.300	+	1.000			=	3.050	m
Ww5	Ww5	=	2.300	Xw5=	W3	–	Ww5x2/3							
					5.100	–	1.533					=	3.567	m
	Hw5	=	0.300	Yw5=	Hw5/3	+	H3							
					0.100	+	1.000					=	1.100	m

Guide wall

Gw	Wgw	=	3.000	Xgw=	Wgw/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800			=	4.300	m
	Hgw	=	1.200	Ygw=	Ht	+	Hgw/2							
					8.800	+	0.600					=	9.400	m

Approach slab

Apr	Wapr	=	3.000	Xapr=	Wapr/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800			=	4.300	m
	Hapr	=	0.200	Yapr=	Ht	–	H1	+	Hapr/2					
					8.800	–	1.945	+	0.100			=	6.955	m

Asphalt

Ha = 0.05 m

Asp	Wasp	=	3.000	Xasp=	W9/2	+	W2	+	Wf3					
					1.500	+	1.000	+	1.800			=	4.300	m
	Hasp	=	0.050	Yasp=	Ht	–	Hasp/2							
					8.800	–	0.025					=	8.775	m

Back fill HWL

a. In case High Water Level

Hwl elvation	=	30.905	m						
Lwl elvation	=	27.310	m	lower than base footing elevation					
Free board	=	6.005	m						
Top deck elvation	=	Hwl elv.	+	Free board	+	depth of beam and deck			
	=	30.905	+	4.550	+	1.845	=	37.300	m
Base foting elv.	=	37.300	–	8.800	=	28.500	m		
Top footing elv.	=	28.500	+	1.000	=	29.500	m		
Depth of back fill (H bf)	=	37.300	–	29.500	=	7.800	m		

x–y

Depth of wet soil

H wet.l	=	Top deck elv.	−	Hwl elv.--->	Hwl elv. under base footing elv.					
	=	37.300	−	30.905	=	6.395	m			
H wet.r	=	Hwc	−	Top footing elv.						
	=	30.105	−	29.500	=	0.605	m			
Depth of saturated soli	=	H bf	−	H wet						
H sat	=	7.800	−	6.395	=	1.405	m			

a. soil wet condition

wet.l	Wwet.l	=	2.300	X1=	Wwet.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hwet.l	=	6.395	Y1=	Ht	−	Hwet.l/2					
					8.800	−	3.197			=	5.602	m
wet.r	Wwet.r	=	1.800	X2=	Wf3/2							
					0.900					=	0.900	m
	Hwet.r	=	0.605	Y2=	Hwet.r/2	+	H3					
					0.303	+	1.000			=	1.303	m

b. soil saturated condition

sat.l	Wsat.l	=	2.300	X1=	Wsat.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hsat.l	=	1.405	Y1=	Hsat.l/2	+	H3					
					0.703	+	1.000			=	1.703	m
sat.r	Wsat.r	=	1.800	X2=	Wsat.r/2							
					0.900					=	0.900	m
	Hsat.r	=	1.405	Y2=	Hsat.r/2	+	H3					
					0.703	+	1.000			=	1.703	m

b. In case Low Water Level

Depth of wet soil on left side footing

H wet.l		Top footing elv.		Hwl elvation			
	=	37.300	−	29.500	=	7.800	m

Depth of wet soil on right side footing

H wet.r	=	Hwc elv.	−	Top footing elv.			
	=	31.705	−	29.500	=	2.205	m

Depth of saturated soli HWL = Hstr

Hsat	=	7.800	−	7.800	=	0.000	m

a. soil wet condition

wet.l	Wwet.l	=	2.300	X1 =	Wwet.l/2	+	W2	+	Wf3			
					1.150	+	1.000	+	1.800	=	3.950	m
	Hwet.l	=	7.800	Y1 =	Hwet.l/2	+	H3					
					3.900	+	1.000			=	4.900	m
wet.r	Wwet.r	=	1.800	X2 =	Wwet.r/2							
					0.900					=	0.900	m
	Hwet.r	=	2.205	Y2 =	Hwet.r/2	+	H3					
					1.103	+	1.000			=	2.103	m

b. soil saturated condition

sat.l	Wsat.l	=	2.300	X1 =	Wsat.l/2	+	W2	+	Wf3			
					1.150	+	0.000	+	ERR	=	ERR	m
	Hsat.l	=	0.000	Y1 =	Hsat.l/2	+	H3					
					0.000	+	1.000			=	0.000	m
sat.r	Wsat.r	=	1.800	X2 =	Wsat.r/2							
					0.900					=	0.900	m
	Hsat.r	=	0.000	Y2 =	Hsat.r/2	+	H3					
					0.000	+	0.200			=	0.000	m

x−y

Project : Medan Flood Control Channel : Medan Flood Way Structure: Br − F 1 Station : Fw 06 + 90	Japan International Cooperation Agency (JICA)	Calculation sheet Date Nos of sheet Prepared by

II.2 Lateral earth pressure due to earthquake

Kh = C x I x S

Kh = coefficient of horizontal siesmic loading

C = the base shear coefficient,base on the data :

siesmic zone and soil condition

Siesmic zone = 4

soil condition soft soil C = 0.15

S = the structure type factor = 1

I = the importance factor

for bridge carrying more than 2.000 vehicle per day

I = 1.2

C	I	S	kh
0.15	1.2	1	0.18

for all other permanent bridge

I = 1

C	I	S	kh
0.15	1	1	0.15

for temporary bridge

I = 0.8

C	I	S	kh
0.15	0.8	1	0.12

soil condition firm soil C = 0.10

for bridge carrying more than 2.000 vehicle per day

C	I	S	kh
0.1	1.2	1	0.12

for all other permanent bridge

C	I	S	kh
0.1	1.00	1	0.10

for temporary bridge

C	I	S	kh
0.1	0.8	1	0.08

source,Bridge Management System

eq

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet
Channel : Medan Flood Way		Date
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Station : Fw 06 + 90		Prepared by

II.4 Columb's coefificient

Right side Abutment

Normal condition

ø	=	30.00	deg.	ø – alpa	=	30.00	–	0.0	= 30.00	deg.
alpa	=	0.0	deg.	ø + delta	=	30.00	+	30.00	= 60.00	deg.
Q	=	0.0	deg.	ø – beta	=	30.00	–	0.0	= 30.00	deg.
delta	=	30.00	deg.	alpa + delta	=	0.0	+	30.00	= 30.00	deg.
beta	=	0.0	deg.	alpa – beta	=	0.0	–	0.000	= 0.00	deg.

$$Ka = \frac{\cos^2(\text{ø} - \text{alpa})}{\cos^2 \text{alpa}.\cos(\text{alpa} + \text{delta}).\left\{(1 + \sqrt{\frac{\sin(\text{ø} + \text{delta}).(\sin(\text{Ø} - \text{beta})}{\cos(\text{alpa} + \text{delta}).\cos(\text{alpa} - \text{beta})}})\right\}^2}$$

Cos(alpa)	=	1.000	sin(ø + delta)	=	0.866
Cos ^ 2 (alpa)	=	1.000	sin(ø – beta)	=	0.500
Cos(ø – alpa)	=	0.866	cos(alpa + delta)	=	0.866
Cos ^ 2 (ø – alpa)	=	0.750	cos(alpa – beta)	=	1.000

A = sin(ø+delta).sin(ø–beta) = 0.866 x 0.500 = 0.433

B = cos (alpa + delta).cos(alpa–beta) = 0.866 + 1.000 = 0.866

C = cos ^ 2 (alpa).cos(alpa+delta) = 1.000 x 0.866 = 0.866

@sqrt(A/B) = 0.71

D = (1 + @sqrt(A/B) ^ 2 = (1.000 + 0.707) ^ 2 = 2.914

C.D = 0.866 x 2.914 = 2.524

$$Ka = \frac{\cos^2(\text{ø}-\text{alpa})}{C.D} = \frac{0.75}{2.52} = 0.297$$

Earth quake condition

$$Ke = \frac{\cos(\text{ø} - \text{alpa} - \text{Qo})^2}{\cos \text{Qo}.\cos^2 \text{alpa}.\cos(\text{alpa} + \text{delta}^{\wedge} + \text{Qo}).\left\{(1 + \sqrt{\frac{\sin(\text{ø} + \text{delta}).(\sin(\text{Ø} - \text{beta} - \text{Qo})}{\cos(\text{alpa} + \text{delta} + \text{Qo}).\cos(\text{alpa} - \text{beta})}})\right\}^2}$$

Qo = composite siesmic angle

$$k' = \tan^{\wedge} -1.k = \frac{Y}{Y-1} \times k$$

k = siesmic coefficient in air = 0.15

Y = 2.00

Y – 1 = 1.00

colum

$$k' = \frac{Y}{Y-1} \times k = \frac{2.00}{1.00} \times 0.15 = 0.30$$

Qo = @atan ^ –1.k = 8.5308

ø	=	30.00	deg.	ø – alpa–Qo	=	30.00	–	0.00	– 8.53	= 21.47
alpa	=	0.00	deg.	ø + delta	=	30.00	+	15.00		= 45.00
Q	=	8.53	deg.	ø – beta–Qo	=	30.00	–	0.00	– 8.53	= 21.47
delta	=	15.00	deg.	ø – beta + Qo	=	30.00	–	0.00	+ 8.53	= 38.53
beta	=	0.00	deg.	alpa + delta+Qo	=	0.00	+	15.00	+ 8.53	= 23.53
				alpa – beta	=	0.000	–	0.000		= 0.00

Cos(Qo)	=	0.989			
Cos(alpa)	=	1.000	sin(ø + delta)	=	0.707
Cos ^ 2 (alpa)	=	1.000	sin(ø – beta – (	=	0.366
Cos(ø – alpa – Qo)	=	0.931	cos(alpa + delta	=	0.917
Cos ^ 2 (ø – alpa–Qo) ^ 2	=	0.866	cos(alpa – beta)	=	1.000

A = sin(ø+delta).sin(ø–beta–Qo) = 0.707 x 0.366 = 0.259

B = cos (alpa + delta+Qo).cos(alpa–beta) = 0.917 + 1.000 = 0.917

C = cos Qo.Cos ^ 2(alpa).cos(alpa+delta+Qo) = 0.989 x 1.000 x 0.92 = 0.907

@sqrt(A/B) = 0.531

D = (1 + @sqrt(A/B) ^ 2 = (1.000 + 0.531) ^ 2 = 2.345

C.D = 0.907 x 2.345 = 2.126

$$Ke = \frac{\cos^2(\text{ø}-\text{alpa})}{C.D} = \frac{0.87}{2.126} = 0.407$$

colum

Project : Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel : Medan Flood Way		Date	
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II.3 Axial load to Abutment

a. Superstucture

Vertical load/m'
Length of abutment = 10.00 m
Depth of abutment = 8.80 m
Width of footing = 5.10 m

Vertical load on abutment :

Descriptic	Dead load ton	Line load ton	Uniform load ton	pedertrian load ton	Total load ton
Total	485.31	27.27	190.60	18.60	721.78
per Abt.	242.66	13.64	95.30	9.30	360.89
per m'	24.27	1.36	9.53	0.93	36.09

Siesmic coefficien = 0.15
Horizontal load
Heq = 0.150 x Rdl
= 0.150 x 24.266
= 3.640 ton/m'
Acting point of siesmic load

Wf3 = 1.80 m
H3 = 1.00 m

X = 0.300 + WF3
= 0.300 + 1.80
= 2.100 m

Y = H2 + H3
= 5.885 + 1.00
= 6.89 m

b. Abutment section

Self weight

Sec–tion	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
A1	0.30	1.945	1.00	1.00	2.40	1.400	1.400	2.950	7.827	4.131	4.131
A2	1.00	5.885	1.00	1.00	2.40	14.124	14.124	2.300	3.927	32.485	32.485
A3	5.10	1.00	1.00	1.00	2.40	12.240	12.240	2.550	0.500	31.212	31.212
A4	0.55	0.50	1.00	1.00	2.40	0.660	0.660	3.075	6.355	2.030	2.030
A5	0.55	0.25	1.00	1.00	2.40	0.165	0.165	2.983	6.522	0.492	0.492
A6	0.20	0.50	1.00	1.00	2.40	0.240	0.240	1.700	5.688	0.408	0.408
A7	0.20	0.50	1.00	1.00	2.40	0.120	0.120	1.733	6.522	0.208	0.208
A8	2.30	0.30	1.00	1.00	2.40	0.828	0.828	4.333	1.100	3.588	3.588
A9	1.80	0.30	1.00	1.00	2.40	0.648	0.648	1.200	1.100	0.778	0.778
					sum		30.43			75.33	75.33
Wing wall and guard wall											
Ww1	3.000	3.000	0.40	2.00	2.400	1.728	0.173	4.300	7.300	0.743	0.743
Ww2	2.300	1.000	0.40	2.00	2.400	0.442	0.044	3.950	5.300	0.174	0.234
Ww3	0.400	1.000	0.40	2.00	2.400	0.077	0.008	5.333	5.467	0.041	0.042
Ww4	2.300	3.500	0.40	2.00	2.400	1.546	0.155	3.950	3.050	0.611	0.471
Ww5	2.300	0.300	0.40	2.00	2.400	0.132	0.013	0.533	1.100	0.007	0.015
Gw	3.000	1.200	0.40	2.00	2.000	0.576	0.058	4.300	9.400	0.248	0.541
					sum		0.392			1.576	1.505
Miscellaneous load Aproaach Road,Guide wall and Asphalt											
Aps	3.00	0.20	1.00	1.00	2.400	1.44	1.440	4.300	6.955	6.192	10.015
asp	3.00	0.05	1.00	1.00	2.300	0.35	0.345	4.300	8.755	1.483	3.020
					sum		1.785			7.675	13.036
					total		32.60			84.58	89.87

axl–lod

Centre of gravity

X = Gv/m'.X / Gv/m' = 84.583 / 32.603 = 2.594 m

Y = Gv/m'.Y / Gv/m' = 89.872 / 32.603 = 2.757 m

H–filling = 0.150 x 32.603 = 4.890 ton

c. Back fill

a. Incase High Water level

Depth of back fill = 7.800 m
H wet.l = 6.395 m
H wet.r = 4.450 m
H saturated = 1.405 m

Sec–tion	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	6.395	1.00	1.00	1.850	27.211	27.211	3.950	5.603	107.48	152.46
Wet.r	1.800	4.450	1.00	1.00	1.850	14.819	14.819	0.900	1.303	13.34	19.31
Sat.l	2.300	1.405	1.00	1.00	2.000	6.463	6.463	3.950	1.703	25.529	11.006
Sat.r	1.800	1.405	1.00	1.00	2.000	5.058	5.058	0.900	1.703	4.552	8.614
					sum		53.550			150.900	191.390

X = Gv/m'.X / Gv/m' = ******** / 53.550 = 2.818 m

Y = Gv/m'.Y / Gv/m' = 191.390 / 53.550 = 3.574 m

H–filling = 0.150 x 53.550 = 8.033 ton

b. Low water level

Depth of Hwet.l = 7.800 m
Depth of Hwet.r = 4.450 m
Depth of H saturated = 0.000 m

a. Wet condition

Sec–tion	width m	depth m	length m	nos	Yc t/m3	G / m'	Gv/m' m3	X m	Y m	G.X m3	G.Y m3
Wet.l	2.300	7.800	1.00	1.00	1.850	33.189	33.189	3.950	4.900	131.097	162.626
Wet.r	1.800	4.450	1.00	1.00	1.850	14.819	14.819	0.900	2.103	13.337	31.163
Sat.l	2.300	0.000	1.00	1.00	2.000	0.000	0.000	3.950	0.000	0.000	0.000
Sat.r	1.800	0.000	1.00	1.00	2.000	0.000	0.000	0.900	0.000	0.000	0.000
					sum		48.008			144.433	193.789

Habt 0.150 x 48.008 = 7.201 ton

Centre of gravity

X = Gv/m'.X / Gv/m' = ******** / 48.008 = 3.009 m

Y = Gv/m'.Y / Gv/m' = 193.789 / 48.008 = 4.037 m

axl–lod

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II.5 Horizontal force at Abutment

II.5.1 Case – I ,Normal Condition (HWL)

Depth of abutment	=	8.80	m			
Surcharge load	=	1.00	t/m2			
Unit weight wet soil	=	1.85	t/m3			
Unit weight saturated soil	=	2.00	t/m3			
Unit weight of water	=	1.00	t/m3			
Width of footing						
Wf1	=	2.30	m			
Wf2	=	1.00	m			
Wf3	=	1.80	m			
W3	=	5.10	m			
Elevation of Lwl	=	27.310	m			
Elevation of Hwl	=	30.905	m			
Top slab elevation	=	37.300	m			
Depth of footing	=	1.000	m			
Elv.of base footing	=	37.300	–	8.80	=	28.500 m
Elv.of top footing	=	28.500	+	1.00	=	29.500 m
Depth of back fill	=	37.300	–	29.500	=	7.800 m

Depth of wet soil = H wet

H wet = Top elv. – Hwl elv.

H wet = 37.300 – 30.905 = 6.395 m

Depth of saturated soil = H sat

H sat = 7.80 – 6.395 = 1.405 m

A Active earth pressure

By live load

Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.800	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ka = 0.297

Pq = q x H x L x Ka

Pq = 1.000 x 7.800 x 1.000 x 0.297

Pq = 2.317 ton

Pqv	=	Hq x Sin(alpha)	Pqh	=	Hq x Cos(alpha)	
	=	2.317 x 0.000		=	2.317 x 1.000	
	=	0.000 ton		=	2.317 ton	
X	=	5.100 m	Y	=	7.800 : 2.000	
				=	3.900 m	

B By earth

B–1 Wet soil

Length = 1.000 m

Hwet = 6.395 m

Hsat = 1.405 m

fh–1

1. Load triangular

Pw = 0.500 x Ywet x Hwet^2 x L x Ka

Pw = 0.500 x 1.850 x 40.896 x 1.000 x 0.297

Pw = 11.235 ton

Pw(v)	=	Pw x Sin(alpha)	Pw(b)	=	Pw x Cos(alpha)	
	=	11.235 x 0.000		=	11.235 x 1.000	
	=	0.000 ton		=	11.235 ton	
X	=	5.100 m	Y	=	6.395 : 3.000 + 1.405	
				=	3.537 m	

B–2 Saturated

H sat = 1.405 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ka

Ps1 = 2.000 x 1.405 x 1.000 x 0.297

Ps1 = 0.835 ton

Ps1(v)	=	H sat x Sin(alpha)	Ps1(h)	=	H sat x Cos(alpha)	
	=	0.835 0.000		=	0.835 x 1.000	
	=	0.000 ton		=	0.835 ton	
X	=	5.100 m	Y	=	1.405 : 2.000	
				=	0.703 m	

3. Load triangular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ka

Ps2 = 0.500 x 2.000 x 1.974 x 1.000 x 0.297

Ps2 = 0.586 ton

Ps2(v)	=	H sat–2 x Sin(alpha)	Ps2(h)	=	H sat–2 x Cos(alpha)	
	=	0.586 x 0.000		=	0.586 x 1.000	
	=	0.000 ton		=	0.586 ton	
X	=	5.100 m	Y	=	1.405 : 3.000	
				=	0.468 m	

4. Water

Hw = 1.405 m

Pw	=	0.500 x Yw x Hw^2 x L				
	=	0.500 x 1.000 x 1.974 x 1.000				
	=	0.987 ton				
X	=	5.100 m				
Y	=	1.405 : 3.000				
	=	0.468 m				

5. Uplife HWL

B = 5.100 m

Pu	=	Hw x B x Yw				
	=	1.405 x 5.100 x 1.000				
	=	7.166 ton/m'				
X	=	5.100 : 2.000				
	=	2.550 m				

fh–1

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II.5.2 Case – II, Normal Condition (LWL)

Depth of abutment	=	8.80	m			
Surcharge load	=	1.00	t/m2			
Unit weight wet soil	=	1.85	t/m3			
Unit weight saturated soil	=	2.00	t/m3			
Unit weight of water	=	1.00	t/m3			
Width of footing						
Wf1	=	2.30	m			
Wf2	=	1.00	m			
Wf3	=	1.80	m			
W3	=	5.10	m			
Elevation of Lwl	=	27.310	m			
Elevation of Hwl	=	30.905	m			
Top slab elevation	=	37.300	m			
Depth of footing	=	1.000	m			
Elv.of base footing	=	37.300	–	8.80	=	28.500 m
Elv.of top footing	=	28.500	+	1.00	=	29.500 m
Depth of back fill	=	37.300	–	29.500	=	7.800 m

Depth of wet soil = H wet

H wet = Top elv. – Lwl elv.

H wet	=	37.300	–	29.500	=	7.800 m

Depth of saturated soil = H sat

H sat	=	7.80	–	7.800	=	0.000 m

A Active earth pressure

By live load

Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.800	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ka = 0.297

Pq = q x H x L x Ka

Pq = 1.000 x 7.800 x 1.000 x 0.297

Pq = 2.317 ton

Pqv	=	Hq	x Sin(alpha)	Pqh	=	Hq x Cos(alpha)
	=	2.317	x 0.000		=	2.317 x 1.000
	=	0.000 ton			=	2.317 ton
X	=	5.100 m		Y	=	7.800 : 2.000
					=	3.900 m

B By earth

B–1 Wet soil

Length = 1.000 m

Hwet = 7.800 m

Hsat = 0.000 m

1. Load triangular

Pw = 0.500 x Ywet x Hwet^2 x L x Ka

Pw = 0.500 x 1.850 x 60.840 x 1.000 x 0.297

Pw = 16.714 ton

Pw(v)	=	Pw	x Sin(alpha)	Pw(h)	=	Pw x Cos(alpha)
	=	16.714	x 0.000		=	16.714 x 1.000
	=	0.000 ton			=	16.714 ton
X	=	5.100 m		Y	=	7.800 : 3.000 + 0.000
					=	2.600 m

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ka

Ps1 = 2.000 x 0.000 x 1.000 x 0.297

Ps1 = 0.000 ton

Ps1(v)	=	H sat	x Sin(alpha)	Ps1(h)	=	H sat x Cos(alpha)
	=	0.000	0.000		=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 2.000
					=	0.000 m

3. Load triangular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ka

Ps2 = 0.500 x 2.000 x 0.000 x 1.000 x 0.297

Ps2 = 0.000 ton

Ps2(v)	=	H sat–2	x Sin(alpha)	Ps2(h)	=	H sat–2 x Cos(alpha)
	=	0.000	x 0.000		=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 3.000
					=	0.000 m

4. Water

Hw = 0.000 m

Pw = 0.500 x Yw x Hw^2 x L

Pw = 0.500 x 1.000 x 0.000 x 1.000

Pw = 0.000 ton

X = 5.100 m

Y = 0.000 : 3.000

= 0.000 m

5. Uplife HWL

B = 5.100 m

Pu = Hw x B x Yw

Pu = 0.000 x 5.100 x 1.000

Pu = 0.000 ton/m'

X = 5.100 : 2.000

= 2.550 m

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II.5.3 Case – III, Earthquake Condition (HWL)

Depth of abutment	=	8.80	m			
Surcharge load	=	1.00	t/m2			
Unit weight wet soil	=	1.85	t/m3			
Unit weight saturated soil	=	2.00	t/m3			
Unit weight of water	=	1.00	t/m3			
Width of footing						
Wf1	=	2.30	m			
Wf2	=	1.00	m			
Wf3	=	1.80	m			
W3	=	5.10	m			
Elevation of Lwl	=	27.310	m			
Elevation of Hwl	=	30.905	m			
Top slab elevation	=	37.300	m			
Depth of footing	=	1.000	m			
Elv.of base footing	=	37.300	–	8.80	=	28.500 m
Elv.of top footing	=	28.500	+	1.00	=	29.500 m
Depth of back fill	=	37.300	–	29.500	=	7.800 m

Depth of wet soil = H wet

H wet = Top elv. – Hwl elv.

H wet = 37.300 – 30.905 = 6.395 m

Depth of saturated soil = H sat

H sat = 7.80 – 6.395 = 1.405 m

A Active earth pressure

By live load

Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.800	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ko = 0.407

Pq = q x H x L x Ko

Pq = 1.000 x 7.800 x 1.000 x 0.407

Pq = 3.175 ton

Pqv	=	Hq x Sin(alpha)		Pqh	=	Hq x Cos(alpha)
	=	3.175 x 0.000			=	3.175 x 1.000
	=	0.000 ton			=	3.175 ton
X	=	5.100 m	Y	=	7.800 :	2.000
				=	3.900 m	

B By earth

B-1 Wet soil

Length = 1.000 m

Hwet = 6.395 m

Hsat = 1.405 m

1. Load trianngular

Pw = 0.500 x Ywet x Hwet^2 x L x Ke

= 0.500 x 1.850 x 40.896 x 1.000 x 0.407

= 15.396 ton

Pw(v)	=	Pw x Sin(alpha)		Pw(h)	=	Pw x Cos(alpha)
	=	15.396 x 0.000			=	15.396 x 1.000
	=	0.000 ton			=	15.396 ton
X	=	5.100 m		Y	=	6.395 : 3.000 + 1.405
					=	3.537 m

B-2 Saturated

H sat = 1.405 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ke

= 2.000 x 1.405 x 1.000 x 0.407

= 1.144 ton

Ps1(v)	=	H sat x Sin(alpha)		Ps1(h)	=	H sat x Cos(alpha)
	=	1.144	0.000		=	1.144 x 1.000
	=	0.000 ton			=	1.144 ton
X	=	5.100 m		Y	=	1.405 : 2.000
					=	0.703 m

3. Load trianngular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ke

= 0.500 x 2.000 x 1.974 x 1.000 x 0.407

= 0.803 ton

Ps2(v)	=	H sat-2 x Sin(alpha)		Ps2(h)	=	H sat-2 x Cos(alpha)
	=	0.803 x 0.000			=	0.803 x 1.000
	=	0.000 ton			=	0.803 ton
X	=	5.100 m		Y	=	1.405 : 3.000
					=	0.468 m

4. Water

Hw = 1.405 m

Pw = 0.500 x Yw x Hw^2 x L

= 0.500 x 1.000 x 1.974 x 1.000

= 0.987 ton

X = 5.100 m

Y = 1.405 : 3.000

= 0.468 m

5. Uplife HWL

B = 5.100 m

Pu = Hw x B x Yw

= 1.405 x 5.100 x 1.000

= 7.166 ton/m²

X = 5.100 : 2.000

= 2.550 m

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II.5.4 Case – IV ,Earthquake Condition (LWL)

Depth of abutment	=	8.80	m			
Surcharge load	=	1.00	t/m2			
Unit weight wet soil	=	1.85	t/m3			
Unit weight saturated soil	=	2.00	t/m3			
Unit weight of water	=	1.00	t/m3			
Width of footing						
Wf1	=	2.30	m			
Wf2	=	1.00	m			
Wf3	=	1.80	m			
W3	=	5.10	m			
Elevation of Lwl	=	27.310	m			
Elevation of Hwl	=	30.905	m			
Top slab elevation	=	37.300	m			
Depth of footing	=	1.000	m			
Elv.of base footing	=	37.300	–	8.80	=	28.500 m
Elv.of top footing	=	28.500	+	1.00	=	29.500 m
Depth of back fill	=	37.300	–	29.500	=	7.800 m

Depth of wet soil = H wet

H wet	=	Top elv.	–	Lwl elv.		
H wet	=	37.300	–	29.500	=	7.800 m
Depth of saturated soil	=	H sat				
H sat	=	7.80	–	7.800	=	0.000 m

A Active earth pressure
By live load
Surcharge load = (q)

q	=	1.000 t/m2	Sin(alpha)	=	0.000	
delta	=	0.000	L	=	1.000	m
alpa	=	0.000	H	=	7.800	m
Cos(alpha	=	1.000	B	=	5.100	m

oefficient of active pressure Ke = 0.407

Pq = q x H x L x Ke
Pq = 1.000 x 7.800 x 1.000 x 0.407
Pq = 3.175 ton

Pqv	=	Hq x Sin(alpha)		Pqh	=	Hq x Cos(alpha)
	=	3.175 x 0.000			=	3.175 x 1.000
	=	0.000 ton			=	3.175 ton
X	=	5.100 m		Y	=	7.800 : 2.000
					=	3.900 m

B By earth

B–1 Wet soil
Length = 1.000 m
Hwet = 7.800 m
Hsat = 0.000 m

1. Load triangular

Pw = 0.500 x Ywet x Hwet^2 x L x Ke
= 0.500 x 1.850 x 60.840 x 1.000 x 0.407
= 22.905 ton

Pw(v)	=	Pw x Sin(alpha)		Pw(h)	=	Pw x Cos(alpha)
	=	22.905 x 0.000			=	22.905 x 1.000
	=	0.000 ton			=	22.905 ton
X	=	5.100 m		Y	=	7.800 : 3.000 + 0.000
					=	2.600 m

B–2 Saturated

H sat = 0.000 m

2. Load rectangular

Ps1 = Ysat x H sat x L x Ke
= 2.000 x 0.000 x 1.000 x 0.407
= 0.000 ton

Ps1(v)	=	H sat x Sin(alpha)		Ps1(h)	=	H sat x Cos(alpha)
	=	0.000 0.000			=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 2.000
					=	0.000 m

3. Load triangular

Ps2 = 0.500 x Ysat x H sat^2 x L x Ke
= 0.500 x 2.000 x 0.000 x 1.000 x 0.407
= 0.000 ton

Ps2(v)	=	H sat–2 x Sin(alpha)		Ps2(h)	=	H sat–2 x Cos(alpha)
	=	0.000 x 0.000			=	0.000 x 1.000
	=	0.000 ton			=	0.000 ton
X	=	5.100 m		Y	=	0.000 : 3.000
					=	0.000 m

4. Water

Hw = 0.000 m

Pw	=	0.500 x	Yw	x	Hw^2 x	L
	=	0.500 x	1.000	x	0.000 x	1.000
	=	0.000 ton				
X	=	5.100 m				
Y	=	0.000 :	3.000			
	=	0.000 m				

5. Uplife HWL

B = 5.100 m

Pu	=	Hw	x	B	x Yw	
	=	0.000	x	5.100	x	1.000
	=	0.000 ton/m'				
X	=	5.100 :	2.000			
	=	2.550 m				

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II.6 Combined load

II.6.1 Case – I , Normal condition (HWL)

Length	L	=	10.00	m
Width of floting	W3	=	5.10	m
Thick of footing	H3	=	1.00	m

	Item		V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
	Super structure	V–sp	36.090		2.100		75.789	
	Abutment	V–abt	32.600		2.594		84.564	
	Back fill	V–bf	53.550		2.818		150.904	
				Active earth pressure				
	Surcharge load	Pq		2.317		3.900		9.036
Wet soil	triangle load	Pw		11.235		3.537		39.738
Sat.soil	rectangular load	Ps1		0.835		0.703		0.587
	triangle load	Ps2		0.586		0.468		0.274
	Water	Pw in		(0.987)		0.468		(0.462)
		Pw out		1.454		0.568		0.826
	Up life	Pu		(7.166)		2.550		(18.273)
		Total	122.240	8.274			311.257	31.726

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{311.257}{122.240} = 2.546\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{31.726}{8.274} = 3.834\ m$$

V = V/m' x L
= 122.24 x 10.00
= 1,222.40 ton

H = H/m' x L
= 8.27 x 10.00
= 82.74 ton

M = V.(X–(0.5.W)) – H.(Y–tb)

0.5 x W = 0.50 x 5.10
= 2.55 m

(X – (0.5xW)) = 2.55 – 2.55
= (0.00) m

(Y – tb) = 3.834 – 1.00
= 2.83 m

H x (Y – tb) = 82.74 x 2.83
= 234.52 t.m

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 1,222.40 x (0.00) – 234.52
= (4.55) – 234.52
= (239.07) t.m

II.6.2 Case – II , Normal condition (LWL)

	Item		Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
	Super structure	V–sp	36.090		2.100		75.789	
	Abutment	V–Abt	32.600		2.594		84.564	
	Back fill	V–bf	48.088		3.574		171.867	
				Active earth pressure				
	Surcharge load	Hq		2.317		3.900		9.036
Wet soil	triangle load	Hwet		16.714		2.600		43.456
Sat.soil	rectangular load	Hsat–1						
	triangle load	Hsat–2						
	Water	Pw in						
		Pw out						
	Up life	Pu						
		Total	116.778	19.031			332.220	52.493

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{332.220}{116.778} = 2.845\ m \qquad Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{52.493}{19.031} = 2.758\ m$$

V = V/m' x L
= 116.78 x 10.00
= 1,167.78 ton

H = H/m' x L
= 19.03 x 10.00
= 190.31 ton

M = V x (X–(0.5 x W)) – (H x (Y–tb))

0.5 x W = 0.500 x 5.10
= 2.55 m

(X – (0.5xW)) = 2.845 – 2.55
= 0.29 m

(Y – tb) = 2.758 – 1.00
= 1.76 m

H x (Y – tb) = 190.31 x 1.76
= 334.62 m

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 1,167.78 x 0.29 – 334.62
= 344.36 – 334.62
= 9.74 t.m

Project	: Medan Flood Control	Japan International Cooperation Agency (JICA)	Calculation sheet	
Channel	: Medan Flood Way		Date	
Structure	: Br – F1		Nos of sheet	
Station	: FW 06 + 090		Prepared by	

II.6.3 Case – III,Earthquake condition (HWL)

Length	L	=	10.00	m	
Width of ffoting	W3	=	5.10	m	
Thick of footing	H3	=	1.00	m	

	Item	V load/m'	H load /m'	Xo	Yo	V.Xo	H.Yo
	Super structure	V–sp	36.090	3.640	2.100	6.890	75.789	25.080
	Abutment	V–abt	32.600	4.890	2.594	2.757	84.564	13.482
	Back fill	V–bf	53.550	8.033	2.818	3.574	150.904	28.710
		Active earth pressure						
	Surcharge load	Pq		2.317		3.900		9.036
Wet soil	triangle load	Pw		11.235		3.537		39.738
Sat.soil	rectangular load	Ps1		0.835		0.703		0.587
	triangle load	Ps2		0.586		0.468		0.274
	Water	Pw in		(0.987)		0.468		(0.462)
		Pw out		1.454		0.568		0.826
	Up life	Pu		(7.166)		2.550		(18.273)
		Total	122.240	24.837			311.257	98.998

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{311.257}{122.240} = 2.546 \text{ m}$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{98.998}{24.837} = 3.986 \text{ m}$$

V = V/m' x L
= 122.24 x 10.00
= 1,222.40 ton

H = H/m' x L
= 24.84 x 10.00
= 248.37 ton

M = V.(X–(0.5.W)) – H.(Y–tb)

0.5 x W = 0.50 x 5.10
= 2.55 m

(X –(0.5xW)) = 2.55 – 2.55
= (0.00) m

(Y – tb) = 3.986 – 1.00
= 2.99 m

H x (Y – tb) = 248.37 x 2.99
= 741.61 t.m

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 1,222.40 x (0.00) – 741.61
= (4.55) – 741.61
= (746.15) t.m

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II.6.4 Case – IV,Earthquake condition (LWL)

	Item	Vo/m'	Ho/m'	Xo	Yo	Vo.Xo	Ho.Yo
	Super structure	V–sp	36.090	3.640	2.100	6.890	75.789	25.080
	Abutment	V–Abt	32.600	4.890	2.594	2.757	84.564	13.482
	Back fill	V–bf	48.088	7.201	3.574	4.037	171.867	29.070
					Active earth pressure			
	Surcharge load	Hq		2.317		3.900		9.036
Wet soil	triangle load	Hwet		16.714		2.600		43.456
Sat.soil	rectangular load	Hsat–1						
	triangle load	Hsat–2						
	Water	Pw in						
		Pw out						
	Up life	Pu						
	Total		116.778	34.762			332.220	********

$$X' = \frac{Vo.Xo}{Vo\ tot} = \frac{332.220}{116.778} = 2.845 \text{ m}$$

$$Y' = \frac{Ho.Yo}{Ho\ tot} = \frac{120.124}{34.762} = 3.456 \text{ m}$$

V = V/m' x L
= 116.78 x 10.00
= 1,167.78 ton

H = H/m' x L
= 34.76 x 10.00
= 347.62 ton

M = V x (X–(0.5 x W)) – (H x (Y–tb))

0.5 x W = 0.500 x 5.10
= 2.55 m

(X –(0.5xW)) = 2.845 – 2.55
= 0.29 m

(Y – tb) = 3.456 – 1.00
= 2.46 m

H x (Y – tb) = 347.62 x 2.46
= 853.62 m

= V x (X–(0.5 x W)) – (H x (Y–tb))
= 1,167.78 x 0.29 – 853.62
= 344.36 – 853.62
= (509.26) t.m

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