NIPPON KOEI CO.,LTD.

DESIGN CALCULATION COVER SHEET

Project	Detailed Design on Port Reactivation Project in La Union Province	**Project Code**	JC1N004
Section	**Civil**	Calc. File No.	
Sub-Section	**Revetmentl**	Calc. Index No.	

Subject: **Small Boat Basin**

Calculation Objective:

Stability of Concrete Block Wall

References, Calculation Notes and Comments

Refer to drawings **RV-04-001,RV-03-002**

Calculation based on

TECHNICAL STANDERDS AND COMMENTARIES

FOR

PORT AND HARBOUR FACILITIES IN JAPAN

Rev	Prepared by	Prepared Date	No. of Pages	Checked by	Checked Date	Reviewed by	Reviewed Date	Superseded by Calc No.
0		24/07/2002	44		26 July 02		26/08/02	
A								
B								
C								

File in Calc. File

FN : Calculation_Cover_Sheet

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References/ Notes

1.Design Conditions

1-1. Dimensions

Crown height	5.000 (m)
Bottom Height	-4.000 (m)

1-2. Tide Level

H.W.L	3.370 (m)
L.W.L	-0.130 (m)

1-3 Residual Water Height

R.W.L	1.033 (m)

1-4. Surcharge

Normal Condition (kN/m²)	Seismic Condition (kN/m²)
19.600	9.800

1-5. Seismic Coefficient

For earth pressure	0.200
For Inertia Force	0.200

1-6. Safety Factor

	Normal Condition	Seismic Condition
Sliding	1.200	1.000
Overturning	1.200	1.100
Bearing Capacity(Sandy Soil)	2.500	2.500
Bearing Capacity(Cohesive Soil)	1.500	1.500

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		26/07/2002		26/07/2002

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Examination Point

a :	(0.000, 3.000)
b :	(0.000, 1.000)
c :	(0.000, -1.500)
d :	(0.000, -4.000)

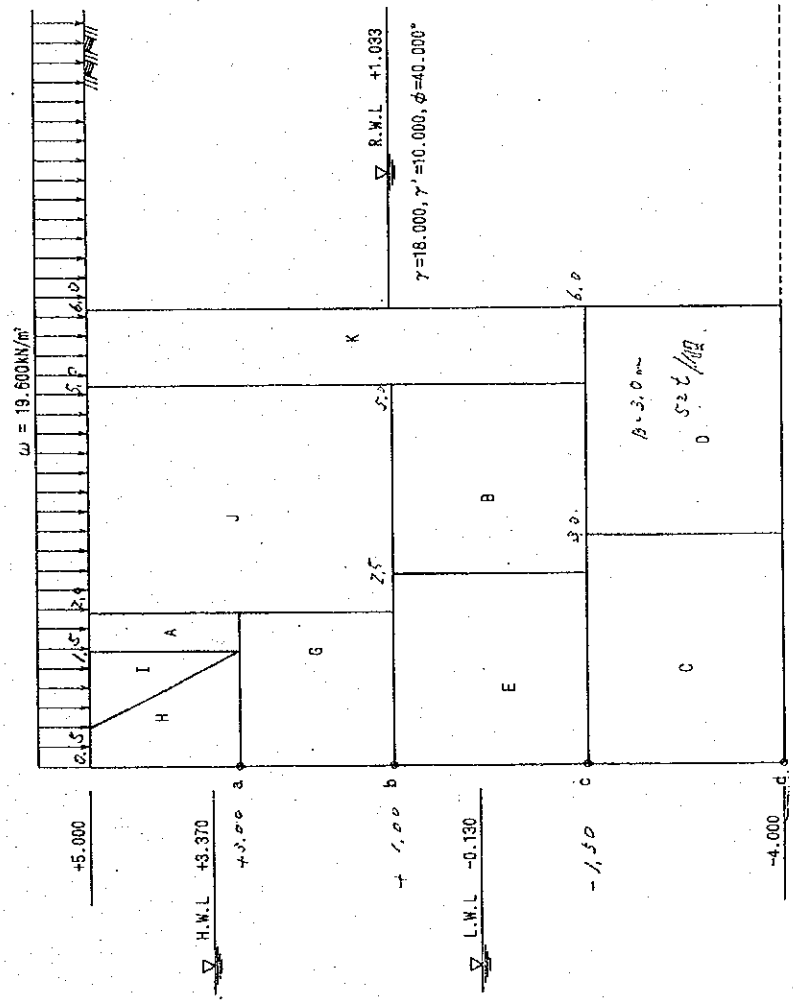

Figure of Examination Condition (Normal Condition)

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2. Stability in Normal Condition

2-1 Earth Pressure and Water Pressure

[1] Coefficient of earth Pressure

$$K_a = \frac{\cos^2(\phi-\psi)}{\cos^2\psi\cdot\cos(\delta+\psi)\left[1+\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi-\beta)}{\cos(\delta+\psi)\cdot\cos(\psi-\beta)}}\right]^2}$$

ここに
K_a : Coefficient of active earth pressure
ϕ : Angle of internal friction(degree)
β : Angle of the ground surface to horizontal(degree)
ψ : Angle of the wall surface to vertical (degree)
δ : Angle of wall friction

Point A; < 3.000m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	K_a
5.000～ 3.000	0.0	40.0	15.0	0.0	0.2011

B; < 1.000m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	K_a
5.000～ 1.033	0.0	40.0	15.0	0.0	0.2011
1.033～ 1.000	0.0	40.0	15.0	0.0	0.2011

C; < -1.500m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	K_a
5.000～ 1.033	0.0	40.0	15.0	0.0	0.2011
1.033～ -1.500	0.0	40.0	15.0	0.0	0.2011

D; < -4.000m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	K_a
5.000～ 1.033	0.0	40.0	15.0	0.0	0.2011
1.033～ -4.000	0.0	40.0	15.0	0.0	0.2011

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[2] Intensity of Earth Pressure

$$P_i = \left[\Sigma \gamma \cdot h + \frac{\omega \cdot \cos\psi}{\cos(\psi - \beta)} \right] \cdot K_i$$

P_i : Intensity of action earth pressure (kN/m2)
γ : Unit weight of soil (kN/m³)
h : Thickness of soil layer (m)
ω : Surcharge (kN/m²)
ψ : Angle of the wall surface to vertical (degree)
β : Angle of the ground surface to horizontal(degree)
K_i : Coefficient of active earth

Point A, < 3.000m , >

Action Level(m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_i (kN/m²)
5.000	0.000	0.000	0.000	0.0	19.600	0.1942	3.806
3.000	2.000	36.000	36.000	0.0	19.600	0.1942	10.798

B, < 1.000m , >

Action Level(m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_i (kN/m²)
5.000	0.000	0.000	0.000	0.0	19.600	0.1942	3.806
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
1.000	0.033	0.330	71.736	0.0	19.600	0.1942	17.737

C, < -1.500m , >

Action Level(m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_i (kN/m²)
5.000	0.000	0.000	0.000	0.0	19.600	0.1942	3.806
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
-1.500	2.533	25.330	96.736	0.0	19.600	0.1942	22.592

D, < -4.000m , >

Action Level(m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_i (kN/m²)
5.000	0.000	0.000	0.000	0.0	19.600	0.1942	3.806
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
1.033	3.967	71.406	71.406	0.0	19.600	0.1942	17.673
-4.000	5.033	50.330	121.736	0.0	19.600	0.1942	27.447

		Prepared by	Y.Ando	Checked by	R.Nisimura
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[3] Earth Pressure

$$P_6 = \frac{1}{2} \cdot P_1 \cdot h$$

P_6 : Earth pressure (kN/m)
h : Thickness of Soil (m)
P_1 : Intensity of active earth pressure (kN/m^2)

A < 3.000m >

No.	Formula	P_1 (kN/m^2)	h (m)	P_6 (kN/m)
1	1/2 x	3.806 x	2.000	3.806
2	1/2 x	10.798 x	2.000	10.798

B < 1.000m >

No.	Formula	P_1 (kN/m^2)	h (m)	P_6 (kN/m)
1	1/2 x	3.806 x	3.967	7.549
2	1/2 x	17.673 x	3.967	35.054
3	1/2 x	17.673 x	0.033	0.292
4	1/2 x	17.737 x	0.033	0.293

C < -1.500m >

No.	Formula	P_1 (kN/m^2)	h (m)	P_6 (kN/m)
1	1/2 x	3.806 x	3.967	7.549
2	1/2 x	17.673 x	3.967	35.054
3	1/2 x	17.673 x	2.533	22.383
4	1/2 x	22.592 x	2.533	28.613

D < -4.000m >

No.	Formula	P_1 (kN/m^2)	h (m)	P_6 (kN/m)
1	1/2 x	3.806 x	3.967	7.549
2	1/2 x	17.673 x	3.967	35.054
3	1/2 x	17.673 x	5.033	44.474
4	1/2 x	27.447 x	5.033	69.070

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[4] Horizontal Earth Pressure and Moment

A. < 3.000m . . >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	3.806	1.333	5.073
2	10.798	0.667	7.202
Total	14.604		12.275

B. < 1.000m . >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	7.549	2.678	20.216
2	35.054	1.355	47.498
3	0.292	0.022	0.006
4	0.293	0.011	0.003
Total	43.188		67.723

C. < -1.500m >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	7.549	5.178	39.089
2	35.054	3.855	135.133
3	22.383	1.689	37.805
4	28.613	0.844	24.149
Total	93.599		236.176

D. < -4.000m . >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	7.549	7.678	57.961
2	35.054	6.355	222.768
3	44.474	3.355	149.210
4	69.070	1.678	115.899
Total	156.147		545.838

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[5] Vertical Earth Pressure and Moment

A; < 3.000m >

No	Vertical Factor of Earth Pressure P_c (kN/m)	$\tan(\psi+\delta)$	P_v (kN/m)	Point (m)	Moment $M_{r,v}$ (kN·m/m)
1	3.806	0.268	1.020	1.500	1.530
2	10.798	0.268	2.894	1.500	4.341
Total			3.914		5.871

B; < 1.000m >

No	Vertical Factor of Earth Pressure P_c (kN/m)	$\tan(\psi+\delta)$	P_v (kN/m)	Point (m)	Moment $M_{r,v}$ (kN·m/m)
1	7.549	0.268	2.023	2.000	4.046
2	35.054	0.268	9.394	2.000	18.788
3	0.292	0.268	0.078	2.000	0.156
4	0.293	0.268	0.079	2.000	0.158
Total			11.574		23.148

C; < -1.500m >

No	Vertical Factor of Earth Pressure P_c (kN/m)	$\tan(\psi+\delta)$	P_v (kN/m)	Point (m)	Moment $M_{r,v}$ (kN·m/m)
1	7.549	0.268	2.023	5.000	10.115
2	35.054	0.268	9.394	5.000	46.970
3	22.383	0.268	5.999	5.000	29.995
4	28.613	0.268	7.668	5.000	38.340
Total			25.084		125.420

D; < -4.000m >

No	Vertical Factor of Earth Pressure P_c (kN/m)	$\tan(\psi+\delta)$	P_v (kN/m)	Point (m)	Moment $M_{r,v}$ (kN·m/m)
1	7.549	0.268	2.023	6.000	12.138
2	35.054	0.268	9.394	6.000	56.364
3	44.474	0.268	11.919	6.000	71.514
4	69.070	0.268	18.511	6.000	111.066
Total			41.847		251.082

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[6] Water Pressure and Moment

$$P_r = \frac{1}{2} \cdot h_r \cdot p_r + h \cdot p_r$$

$$p_r = h_r \cdot \gamma_r$$

P_r : Residual Water Pressure (kN/m) (kN/m)
p_r : Intensity of Residual Water Pressure (under L.W.L) (kN/m²)
h_r : Distance from R.W.L to L.W.L (m)
h : Depth from wall bottom to L.W.L (m)
γ_r : Unit Weight of Water (kN/m)

A. < 3.000m >

B. < 1.000m >

No.	p_r h	P_r (kN/m)	y	$M_{r,r}$ (kN·m/m)
1	1/2 x 0.333x 0.033	0.005	0.011	0.000
Total		0.005		0.000

C. < -1.500m >

No.	p_r h	P_r (kN/m)	y	$M_{r,r}$ (kN·m/m)
1	1/2 x 11.746x 1.163	6.830	1.758	12.007
2	11.746x 1.370	16.092	0.685	11.023
Total		22.922		23.030

D. < -4.000m >

No.	p_r h	P_r (kN/m)	y	$M_{r,r}$ (kN·m/m)
1	1/2 x 11.746x 1.163	6.830	4.258	29.082
2	11.746x 3.870	45.457	1.935	87.959
Total		52.287		117.041

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2-2.: Weight of Wall

[1] Weight and Center of Gravity of Each Block

Filling 《A2》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	0.500x 2.000x20.000 = 20.000	1.750	4.000	35.000	80.000
	20.000	* 1.750	* 4.000	35.000	80.000

k Filling 》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	2.500x 2.500x23.000 = 143.750	3.750	-0.250	539.062	-35.938
	143.750	* 3.750	* -0.250	539.062	-35.938

《D1》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	3.000x 2.500x23.000 = 172.500	1.500	-2.750	258.750	-474.375
	172.500	* 1.500	* -2.750	258.750	-474.375

《D2》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	3.000x 2.500x23.000 = 172.500	4.500	-2.750	776.250	-474.375
	172.500	* 4.500	* -2.750	776.250	-474.375

《C1》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	2.500x 2.500x23.000 = 143.750	1.250	-0.250	179.688	-35.938
	143.750	* 1.250	* -0.250	179.688	-35.938

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《B1》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W·x (kN·m/m)	W·y (kN·m/m)
1	2.000x 1.967x23.000 = 90.482	1.000	2.016	90.482	182.412
2	2.000x 0.033x23.000 = 1.518	1.000	1.016	1.518	1.542
計	92.000	* 1.000	* 2.000	92.000	183.954

《A1》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W·x (kN·m/m)	W·y (kN·m/m)
1	0.500x 2.000x23.000 = 23.000	0.250	4.000	5.750	92.000
2	1/2x 1.000x 2.000x23.000 = 23.000	0.833	3.667	19.159	84.341
計	46.000	* 0.542	* 3.834	24.909	176.341

《AS》

No	B x H x γ = W W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W·x (kN·m/m)	W·y (kN·m/m)
1	1/2x 1.000x 2.000x20.000 = 20.000	1.167	4.333	23.340	86.660
計	20.000	* 1.167	* 4.333	23.340	86.660

《BS》

No	B x H x γ W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W·x (kN·m/m)	W·y (kN·m/m)
1	3.000x 3.967x20.000 = 238.020	3.500	3.016	833.070	717.868
2	3.000x 0.033x20.000 = 1.980	3.500	1.016	6.930	2.012
計	240.000	* 3.500	* 3.000	840.000	719.880

《CS》

No	B x H x γ W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W·x (kN·m/m)	W·y (kN·m/m)
1	1.000x 3.967x20.000 = 79.340	5.500	3.016	436.370	239.289
2	1.000x 2.533x20.000 = 50.660	5.500	-0.234	278.630	-11.854
計	130.000	* 5.500	* 1.750	715.000	227.435

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* Coordinate of Gravity Center

$$x = \frac{\Sigma W \cdot x}{\Sigma W} \qquad y = \frac{\Sigma W \cdot y}{\Sigma W}$$

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[2] Vertical Force of Wall Moment

A) < 3.000m >

No	Name of Block	Weight	W, (kN/m)	Arm Length x (m)	M,, (kN·m/m)
1	A1		46.000	0.542	24.932
2	AS		20.000	1.167	23.340
Total			66.000		48.272

B) < 1.000m >

No	Name of Block	Weight	W, (kN/m)	Arm Length x (m)	M,, (kN·m/m)
1	A2		20.000	1.750	35.000
2	B1		92.000	1.000	92.000
3	A1		46.000	0.542	24.932
4	AS		20.000	1.167	23.340
Total			178.000		175.272

C < -1.500m >

No	Name of Block	Weight	W, (kN/m)	Arm Length x (m)	M,, (kN·m/m)
1	A2		20.000	1.750	35.000
2			143.750	3.750	539.062
3	C1		143.750	1.250	179.688
4	B1		92.000	1.000	92.000
5	A1		46.000	0.542	24.932
6	AS		20.000	1.167	23.340
7	BS		240.000	3.500	840.000
Total			705.500		1734.022

D) < -4.000m >

No	Name of Block	Weight	W, (kN/m)	Arm Length x (m)	M,, (kN·m/m)
1	A2		20.000	1.750	35.000
2			143.750	3.750	539.062
3	D1		172.500	1.500	258.750
4	D2		172.500	4.500	776.250
5	C1		143.750	1.250	179.688
6	B1		92.000	1.000	92.000
7	A1		46.000	0.542	24.932
8	AS		20.000	1.167	23.340
9	BS		240.000	3.500	840.000
10	CS		130.000	5.500	715.000
Total			1180.500		3484.022

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[3] Weight and Gravity Center of Earth Block (Under R.W.L)

《A2》 No Buoyancy

《 》

No	B x H x γ - γ' = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	2.500x 2.500x10.000 = 62.500	3.750	-0.250	234.375	-15.625
Total	62.500	* 3.750	* -0.250	234.375	-15.625

《D1》

No	B x H x (γ - γ' = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	3.000x 2.500x10.000 = 75.000	1.500	-2.750	112.500	-206.250
Total	75.000	* 1.500	* -2.750	112.500	-206.250

《D2》

No	B x H x γ - γ' = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	3.000x 2.500x10.000 = 75.000	4.500	-2.750	337.500	-206.250
Total	75.000	* 4.500	* -2.750	337.500	-206.250

《C1》

No	B x H x γ - γ' = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	2.500x 2.500x10.000 = 62.500	1.250	-0.250	78.125	-15.625
Total	62.500	* 1.250	* -0.250	78.125	-15.625

《B1》

No	B x H x γ - γ' = W W(kN/m)	Gravity Center x (m)	y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	2.000x 0.033x10.000 = 0.660	1.000	1.016	0.660	0.671
Total	0.660	* 1.000	* 1.016	0.660	0.671

《A1》 No Buoyancy

《AS》 No Buoyancy

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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《BS》

No	B x H x (γ - γ') = W W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	3.000x 0.033x10.000 = 0.990	3.500	1.016	3.465	1.006
Total	0.990	* 3.500	* 1.016	3.465	1.006

《CS》

No	B x H x (γ - γ') = W W(kN/m)	Gravity Center x (m)	Gravity Center y (m)	W・x (kN・m/m)	W・y (kN・m/m)
1	1.000x 2.533x10.000 = 25.330	5.500	-0.234	139.315	-5.927
Total	25.330	* 5.500	* -0.234	139.315	-5.927

* Coordination of Gravity Center

$$x = \frac{\Sigma W \cdot x}{\Sigma W} \qquad y = \frac{\Sigma W \cdot y}{\Sigma W}$$

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		26/07/2002		26/07/2002

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[4] Buoyancy and Moment

A < 3.000m >

'No Buoyancy at this point '

B < 1.000m >

No	Name	Weight	Wv (kN/m)	Arm Length x (m)	Mwv (kN·m/m)
1	B1		0.660	1.000	0.660
Total			0.660		0.660

C < -1.500m >

No	Name	Weight	Wv (kN/m)	Arm Length x (m)	Mwv (kN·m/m)
1			62.500	3.750	234.375
2	C1		62.500	1.250	78.125
3	B1		0.660	1.000	0.660
4	BS		0.990	3.500	3.465
Total			126.650		316.625

D < -4.000m >

No	Name	Weight	Wv (kN/m)	Arm Length x (m)	Mwv (kN·m/m)
1			62.500	3.750	234.375
2	D1		75.000	1.500	112.500
3	D2		75.000	4.500	337.500
4	C1		62.500	1.250	78.125
5	B1		0.660	1.000	0.660
6	BS		0.990	3.500	3.465
7	CS		25.330	5.500	139.315
Total			301.980		905.940

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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2-4. Stability of Wall

[1] Sliding

$$F = \frac{\mu \cdot V}{H}$$

[2] Overturning

$$F = \frac{M_t}{M_0}$$

ここに
V : Total Vertical Force (kN/m)
H : Total Horizontal Force (kN/m)
μ : Coefficient of Friction
M_t : Moment of Total Vertical force
M_0 : Moment of Total Horizontal Force (kNm/m)

A, < 3.000m >

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_0 (kN·m/m)
Earth Pressure	3.914	14.604	5.871	12.275
Residual Water Pressure		0.000		0.000
Weight of Wall	66.000		48.272	
Buoyancy	0.000		0.000	
Total	69.914	14.604	54.143	12.275

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F		Allowable Valu
$\frac{0.500 \times 69.914}{14.604}$	2.393	≧1.20	$\frac{54.143}{12.275}$	4.410	≧1.20

B, < 1.000m >

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_0 (kN·m/m)
Earth Pressure	11.574	43.188	23.148	67.723
Residual Water Pressure		0.005		0.000
Weight of Wall	178.000		175.272	
Buoyancy	-0.660		-0.660	
Total	188.914	43.193	197.760	67.723

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F		Allowable Val
$\frac{0.500 \times 188.914}{43.193}$	2.186	≧1.20	$\frac{197.760}{67.723}$	2.920	≧1.20

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

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C, < -1.500m ,a] >

	V (kN/m)	H (kN/m)	M_1 (kN·m/m)	M_0 (kN·m/m)
Earth Pressure	25.084	93.599	125.420	236.176
Residual Water Pressure		22.922		23.030
Weight of Wall	705.500		1734.022	
Buoyancy	-126.650		-316.625	
Total	603.934	116.521	1542.817	259.206

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F		Allowable Values
$\frac{0.500 \times 603.934}{116.521}$	2.591	≧1.20	$\frac{1542.817}{259.206}$	5.952	≧1.20

D< < -4.000m i >

	V (kN/m)	H (kN/m)	M_1 (kN·m/m)	M_0 (kN·m/m)
Earth Pressure	41.847	156.147	251.082	545.838
Residual Water Pressure		52.287		117.041
Weight of Wall	1180.500		3484.022	
Buoyancy	-301.980		-905.940	
Total	920.367	208.434	2829.164	662.879

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F		Allowable Values
$\frac{0.600 \times 920.367}{208.434}$	2.649	≧1.20	$\frac{2829.164}{662.879}$	4.267	≧1.20

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

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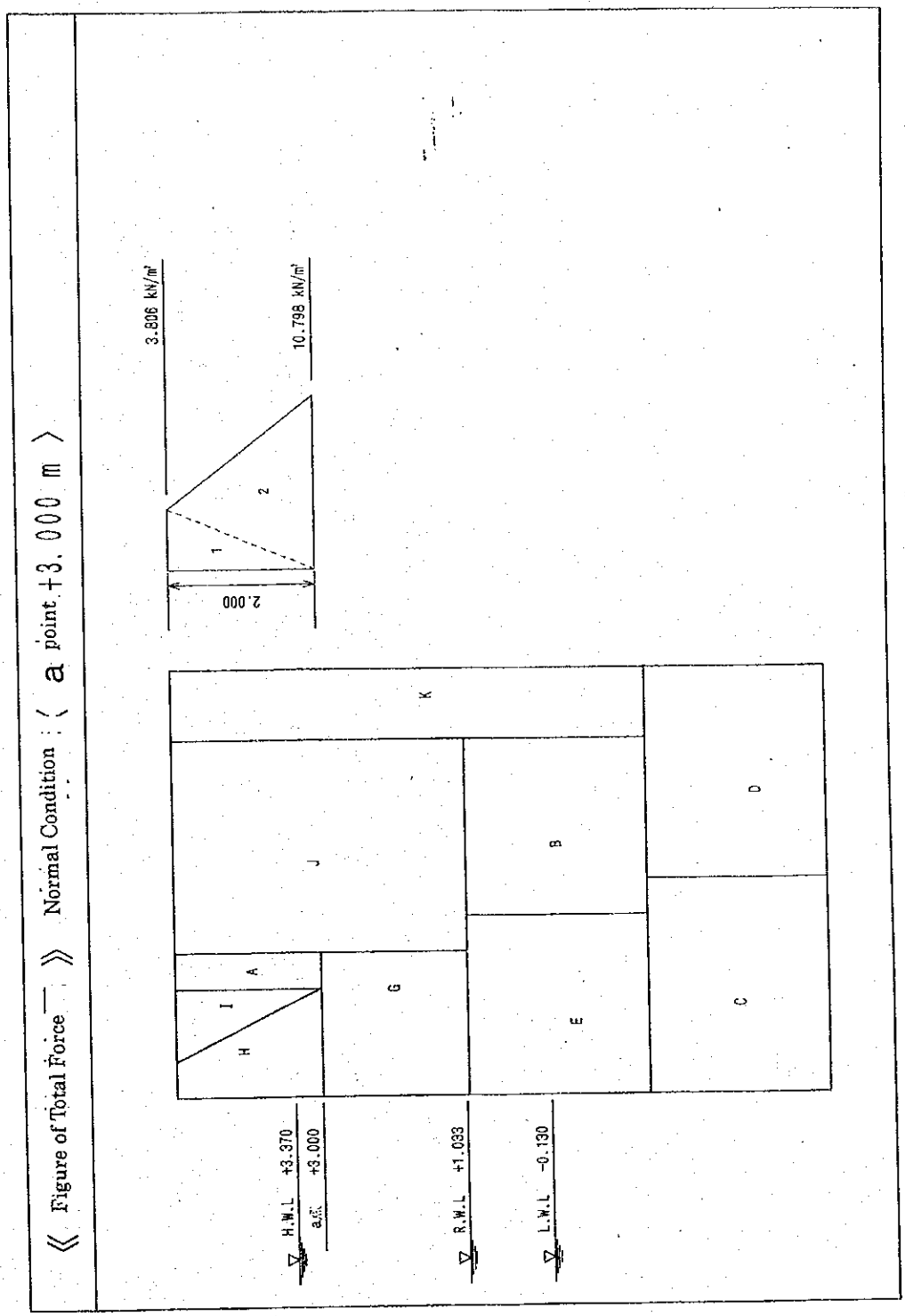

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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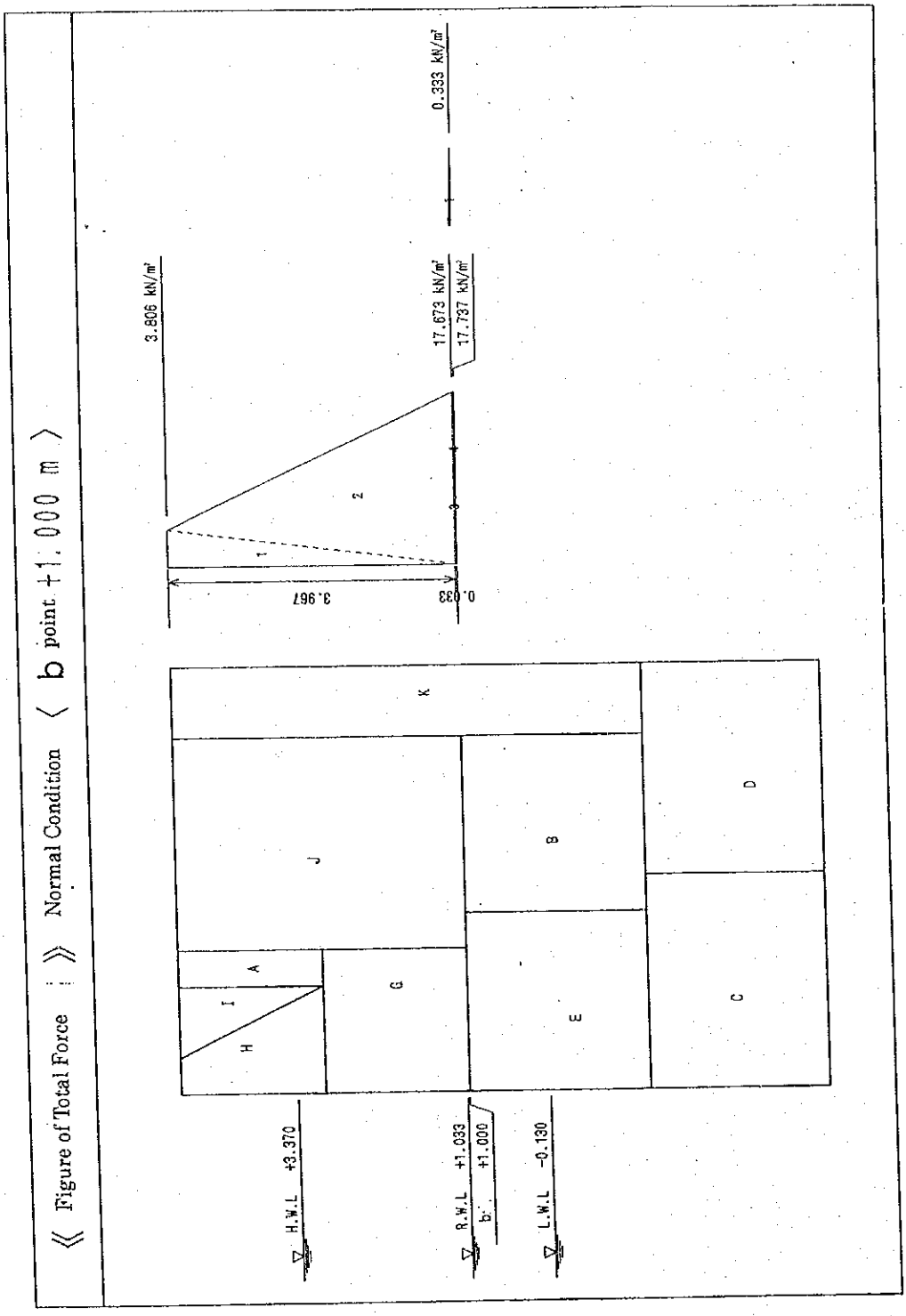

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

FN: Calculation_Sheet

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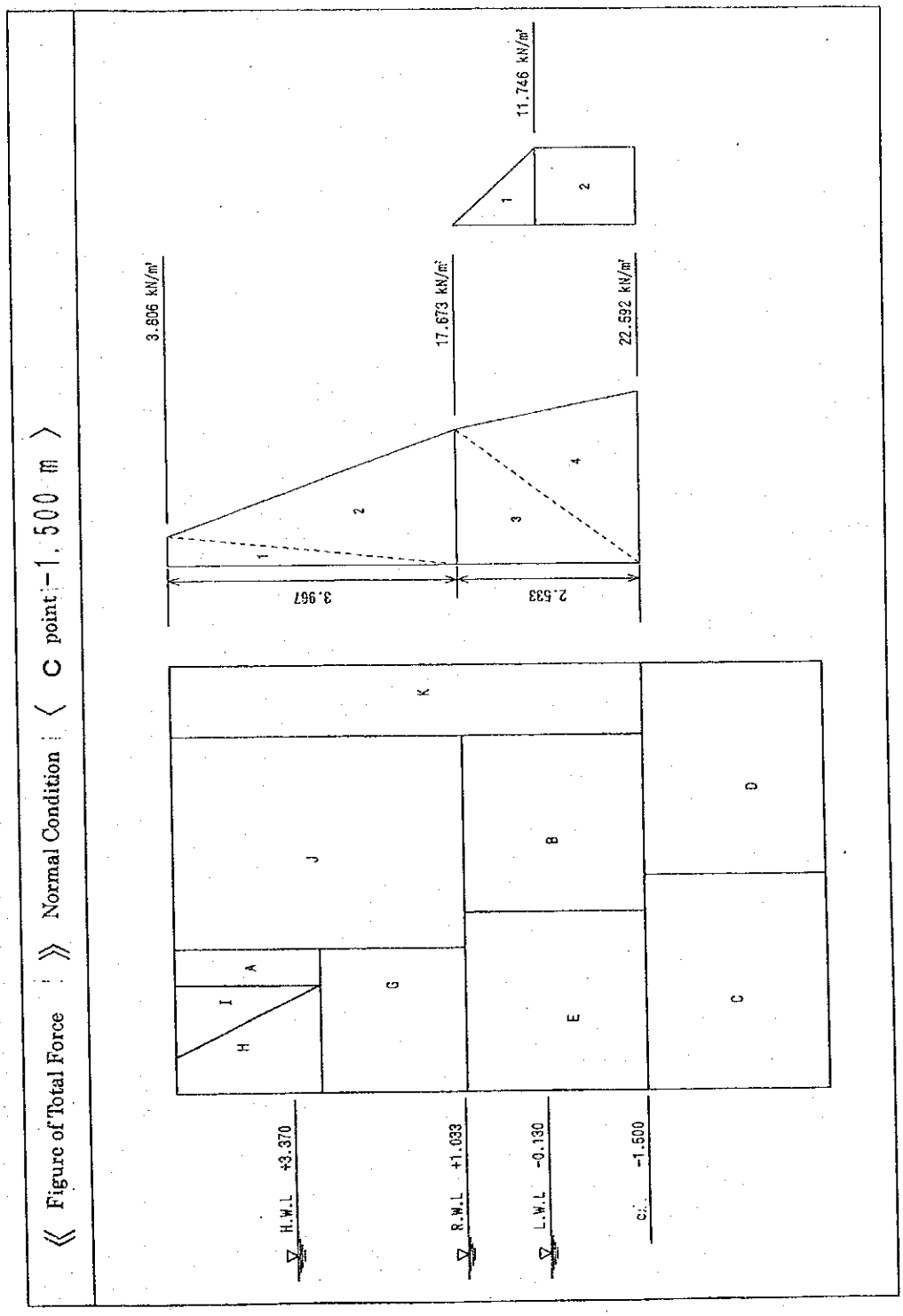
《 Figure of Total Force 》 Normal Condition : 〈 C point : -1.500 m 〉



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
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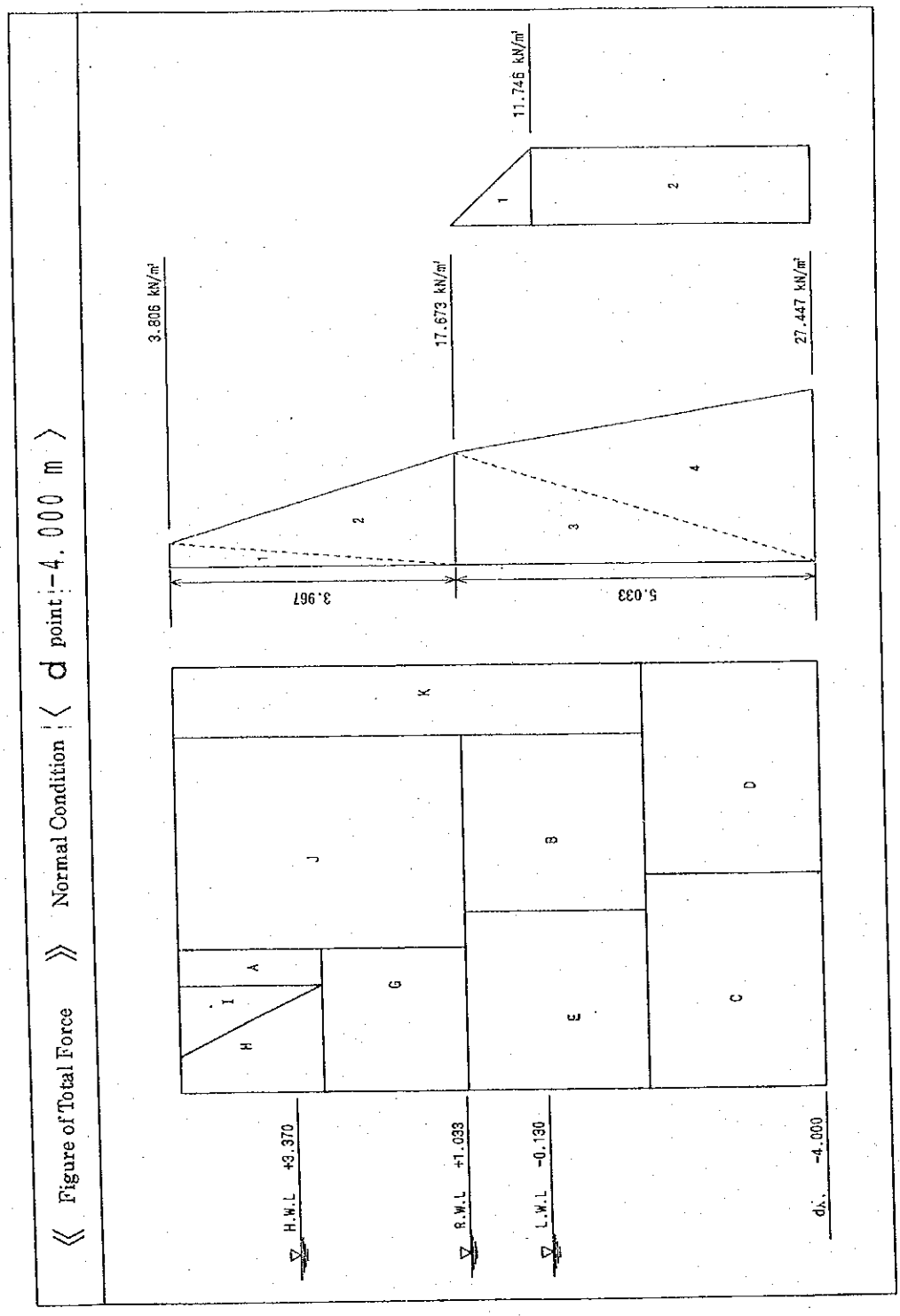

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

FN: Calculation_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
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2-5. Bearing Capacity

[1]. Reaction of Bottom Surface of Block

a) $0 < e \leqq b/6$ の場合

$$p_1 = \left(1 + \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b}$$

$$p_1 = \left(1 - \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b}$$

b) $e > b/6$ の場合

$$p_1 = \frac{2}{3} \cdot \frac{V}{x}$$

$$p_1 = 0$$

$$b' = 3 \cdot x$$

c) $e < 0$ の場合

$$p = \frac{V}{b}$$

ただし

$$x = \frac{M_1 - M_0}{V} \qquad e = \frac{b}{2} - x$$

ここに

p_1	: Maximum Reaction Force	(kN/m²)
p_2	: Minimum Reaction Force	(kN/m²)
b	: Width of Wall	(m)
V	: Vertical resultant force act on wall	(kN/m)
b'	: Distribution width of bottom reactions in case e>b/6	(m)
M_1	: Moment of Vertical force act on wall	(kN·m/m)
M_0	: Moment of Horizontal force act on wall	(kN·m/m)
e	: Eccentricity of resultant force of Vertical and Horizontal	(m)

$$x = \frac{M_1 - M_0}{V} = \frac{2829.164 - 662.879}{920.367} = 2.354 \text{ (m)}$$

$$e = \frac{b}{2} - x = \frac{6.000}{2} - 2.354 = 0.646 \text{ (m)}$$

a) $0 < e \leqq b/6$ の場合

$$p_1 = \left(1 + \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b} = \left(1 + \frac{6 \times 0.646}{6.000}\right) \times \frac{920.367}{6.000} = 252.488 \text{ (kN/m}^2\text{)}$$

$$p_1 = \left(1 - \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b} = \left(1 - \frac{6 \times 0.646}{6.000}\right) \times \frac{920.367}{6.000} = 54.302 \text{ (kN/m}^2\text{)}$$

Maximum Reaction Force ≦ Allowable Bearing Capacity of Rubble Mound

252.488 (kN/m²) ≦ 600.000 (kN/m²) ····· OK

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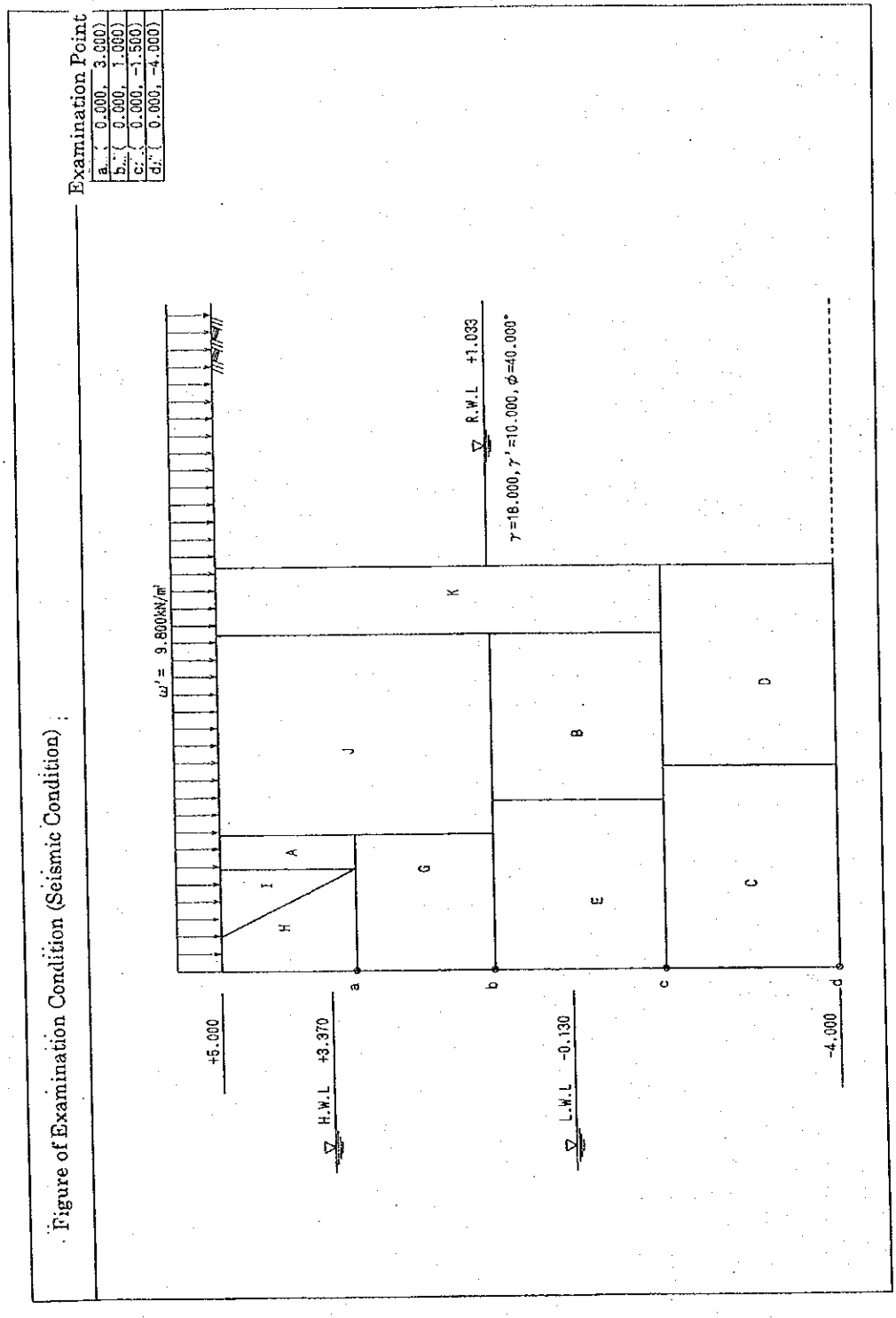

Figure of Examination Condition (Seismic Condition)

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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3. Stability in Seismic Condition

3-1. Earth Pressure and Water Pressure

[1] Coefficient of earth Pressure

$$K_a = \frac{\cos^2(\phi-\psi-\theta)}{\cos\theta\cdot\cos^2\psi\cdot\cos(\delta+\psi+\theta)\left[1+\sqrt{\dfrac{\sin(\phi+\delta)\cdot\sin(\phi-\beta-\theta)}{\cos(\delta+\psi+\theta)\cdot\cos(\psi-\beta)}}\right]^2}$$

K_a : Coefficient of active earth pressure
ϕ : Angle of internal friction(degree)
β : Angle of the ground surface to horizontal(degree)
ψ : Angle of the wall surface to vertical (degree)
δ : Angle of wall friction
θ : Composite seismic angle which is defined as angle by following formula
k : Seismic Coefficient
k' :

Apparent seismic coefficient by following formula

$$k' = \frac{\Sigma\gamma\cdot h + \gamma w\cdot hw + \omega}{\Sigma\gamma\cdot h + \omega'}\cdot k$$

ここに

γ : Unit weight of Soil (kN/m³)
γw : Unit Weight of Water (kN/m³)
h : Thickness of the soil layer(above R.W.L) (m)
hw : Thickness of the soil laver(below R.W.L) (m)
ω : Surcharge (kN/m²)

A . < 3.000m . >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	k or k'	θ (°)	K_a
5.000～ 3.000	0.0	40.0	15.0	0.0	0.20	11.31	0.3168

B . < 1.000m . >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	k or k'	θ (°)	K_a
5.000～ 1.033	0.0	40.0	15.0	0.0	0.20	11.31	0.3168
1.033～ 1.000	0.0	40.0	15.0	0.0	0.20	11.31	0.3168

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			26/07/2002		26/07/2002

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C/ < -1.500m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	k or k'	θ (°)	K_A
5.000～ 1.033	0.0	40.0	15.0	0.0	0.20	11.31	0.3168
1.033～ -1.500	0.0	40.0	15.0	0.0	0.20 0.25	11.31 14.04	0.3168 0.3542

D/ < -4.000m >

Action Level (m)	β (°)	ϕ (°)	δ (°)	ψ (°)	k or k'	θ (°)	K_A
5.000～ 1.033	0.0	40.0	15.0	0.0	0.20	11.31	0.3168
1.033～ -4.000	0.0	40.0	15.0	0.0	0.20 0.28	11.31 15.64	0.3168 0.3785

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[2] Intensity of Earth Pressure

$$P_a = \left[\Sigma \gamma \cdot h + \frac{\omega \cdot \cos\psi}{\cos(\psi - \beta)} \right] \cdot K_a$$

P_a : Intensity of action earth pressure (kN/m2)
γ : Unit weight of soil (kN/m2) (kN/m³)
h : Thickness of soil layer (m)
ω : Surcharge (kN/m²)
ψ : Angle of the wall surface to vertical (degree)
β : Angle of the ground surface to horizontal(degree)
K_a : Coefficient of active earth pressure

A) < 3.000m >

Action Level (m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_a (kN/m²)
5.000	0.000	0.000	0.000	0.0	9.800	0.3060	2.999
3.000	2.000	36.000	36.000	0.0	9.800	0.3060	14.015

B < 1.000m >

Action Level (m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_a (kN/m²)
5.000	0.000	0.000	0.000	0.0	9.800	0.3060	2.999
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
1.000	0.033	0.330	71.736	0.0	9.800	0.3060	24.950

C < -1.500m >

Action Level (m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_a (kN/m²)
5.000	0.000	0.000	0.000	0.0	9.800	0.3060	2.999
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
-1.500	2.533	25.330	96.736	0.0	9.800	0.3421	36.446

D < -4.000m >

Action Level (m)	h (m)	γh (kN/m²)	Σγh (kN/m²)	ψ (°)	ω·cosψ / cos(ψ-β)	Kacos(δ+ψ)	P_a (kN/m²)
5.000	0.000	0.000	0.000	0.0	9.800	0.3060	2.999
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
1.033	3.967	71.406	71.406	0.0	9.800	0.3060	24.849
-4.000	5.033	50.330	121.736	0.0	9.800	0.3656	48.090

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

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[3] Earth Pressure

$$P_e = \frac{1}{2} \cdot P_a \cdot h$$

P_e : Earth pressure (kN/m) N/m)
h : Thickness of Soil (m)
P_a : Intensity of active earth pressure (KN/m²)

A; < 3.000m >

No.	Formula	P_a (kN/m²)	h (m)	P_e (kN/m)
1	1/2 x	2.999 x	2.000	2.999
2	1/2 x	14.015 x	2.000	14.015

B; < 1.000m >

No.	Formula	P_a (kN/m²)	h (m)	P_e (kN/m)
1	1/2 x	2.999 x	3.967	5.949
2	1/2 x	24.849 x	3.967	49.288
3	1/2 x	24.849 x	0.033	0.410
4	1/2 x	24.950 x	0.033	0.412

C; < -1.500m >

No.	Formula	P_a (kN/m²)	h (m)	P_e (kN/m)
1	1/2 x	2.999 x	3.967	5.949
2	1/2 x	24.849 x	3.967	49.288
3	1/2 x	24.849 x	2.533	31.471
4	1/2 x	36.446 x	2.533	46.159

D; < -4.000m >

No.	Formula	P_a (kN/m²)	h (m)	P_e (kN/m)
1	1/2 x	2.999 x	3.967	5.949
2	1/2 x	24.849 x	3.967	49.288
3	1/2 x	24.849 x	5.033	62.533
4	1/2 x	48.090 x	5.033	121.018

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

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[4] Horizontal Earth Pressure and Moment

A < 3.000m >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	2.999	1.333	3.998
2	14.015	0.667	9.348
Total	17.014		13.346

B. < 1.000m >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	5.949	2.678	15.931
2	49.288	1.355	66.785
3	0.410	0.022	0.009
4	0.412	0.011	0.005
Total	56.059		82.730

C < -1.500m , >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	5.949	5.178	30.804
2	49.288	3.855	190.005
3	31.471	1.689	53.155
4	46.159	0.844	38.958
Total	132.867		312.922

D; < -4.000m i >

No	Pressure PH (kN/m)	Arm Length (m)	Moment MPH(kN·m/m)
1	5.949	7.678	45.676
2	49.288	6.355	313.225
3	62.533	3.355	209.798
4	121.018	1.678	203.068
Total	238.788		771.767

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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[5] Vertical Earth Pressure and Moment

A; < 3.000m >

No	Vertical Factor of Earth P_e (kN/m)	$\tan(\psi+\delta)$	Pressure P_v (kN/m)	Point (m)	Moment $M_{P,V}$ (kN·m/m)
1	2.999	0.268	0.804	1.500	1.206
2	14.015	0.268	3.756	1.500	5.634
Total			4.560		6.840

B; < 1.000m >

No	Vertical Factor of Earth P_e (kN/m)	$\tan(\psi+\delta)$	Pressure P_v (kN/m)	Point (m)	Moment $M_{P,V}$ (kN·m/m)
1	5.949	0.268	1.594	2.000	3.188
2	49.288	0.268	13.209	2.000	26.418
3	0.410	0.268	0.110	2.000	0.220
4	0.412	0.268	0.110	2.000	0.220
Total			15.023		30.046

C; < -1.500m >

No	Vertical Factor of Earth P_e (kN/m)	$\tan(\psi+\delta)$	Pressure P_v (kN/m)	Point (m)	Moment $M_{P,V}$ (kN·m/m)
1	5.949	0.268	1.594	5.000	7.970
2	49.288	0.268	13.209	5.000	66.045
3	31.471	0.268	8.434	5.000	42.170
4	46.159	0.268	12.371	5.000	61.855
Total			35.608		178.040

D < -4.000m >

No	Vertical Factor of Earth P_e (kN/m)	$\tan(\psi+\delta)$	Pressure P_v (kN/m)	Point (m)	Moment $M_{P,V}$ (kN·m/m)
1	5.949	0.268	1.594	6.000	9.564
2	49.288	0.268	13.209	6.000	79.254
3	62.533	0.268	16.759	6.000	100.554
4	121.018	0.268	32.433	6.000	194.598
Total			63.995		383.970

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
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[6] Water Pressure and Moment

$$P_r = \frac{1}{2} \cdot h_r \cdot p_r + h \cdot p_r$$

$$p_r = h_r \cdot \gamma_r$$

P_r : Residual Water Pressure (kN/m) (kN/m)
p_r : Intensity of Residual Water Pressure (under L.W.L))
h_r : Distance from R.W.L to L.W.L (m) (m)
h : Depth from wall bottom to L.W.L (m) (m)
γ_r : Unit Weight of Water (kN/m) (kN/m³)

A < 3.000m >
No Residual Water Pressure at this Point

B < 1.000m >

No	p_r	h	P_r (kN/m)	y	$M_{r,x}$ (kN·m/m)
1	1/2 x 0.333x	0.033	0.005	0.011	0.000
Total			0.005		0.000

C. < -1.500m >

No	p_r	h	P_r (kN/m)	y	$M_{r,x}$ (kN·m/m)
1	1/2 x 11.746x	1.163	6.830	1.758	12.007
2	11.746x	1.370	16.092	0.685	11.023
Total			22.922		23.030

D. < -4.000m >

No	p_r	h	P_r (kN/m)	y	$M_{r,x}$ (kN·m/m)
1	1/2 x 11.746x	1.163	6.830	4.258	29.082
2	11.746x	3.870	45.457	1.935	87.959
Total			52.287		117.041

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
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3-2. Dynamic Water Pressure

[1] Dynamic water pressure

$$p_{dw} = \frac{7}{8} \cdot k \cdot \gamma_w \cdot \sqrt{H \cdot y}$$

p_{dw}	: Dynamic water pressure		(kN/m²)
k	: Seismic Coefficient	0.200	
γ_w	: Unit weight of water	10.100	(kN/m³)
H	: Depth of water	3.870	(m)
y	: Depth from water surface to examination point		(m)

[2] total force of Dynamic Water Pressure and Acting Point

$$P_{dw} = \frac{7}{12} \cdot k \cdot \gamma_w \cdot \sqrt{H} \cdot y^{1/1}$$

$$h_{dw} = \frac{2}{5} \cdot y$$

P_{dw}	: Total force of Dynamic Water Pressure	(kN/m)
h_{dw}	: Depth from water surface to examination point	(m)

[3] : Total force of Dynamic Water Pressure and Moment

A) < 3.000m >
No Dynamic Water Pressure at this Point

B) < 1.000m >
No Dynamic Water Pressure at this Point

C, < -1.500m >

$$p_{dw} = \frac{7}{8} \times 0.200 \times 10.100 \times \sqrt{3.870 \times 1.370} = 4.070 \text{ (kN/m²)}$$

$$P_{dw} = \frac{7}{12} \times 0.200 \times 10.100 \times \sqrt{3.870} \times 1.370^{1/1} = 3.717 \text{ (kN/m)}$$

$$h_{dw} = \frac{2}{5} \times 1.370 = 0.548 \text{ (m)}$$

$$M_0 = 3.717 \times 0.548 = 2.037 \text{ (kN·m/m)}$$

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
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D' < -4.000m >

$$P_{1'} = \frac{7}{8} \times 0.200 \times 10.100 \times \sqrt{3.870 \times 3.870} = 6.840 \ (kN/m')$$

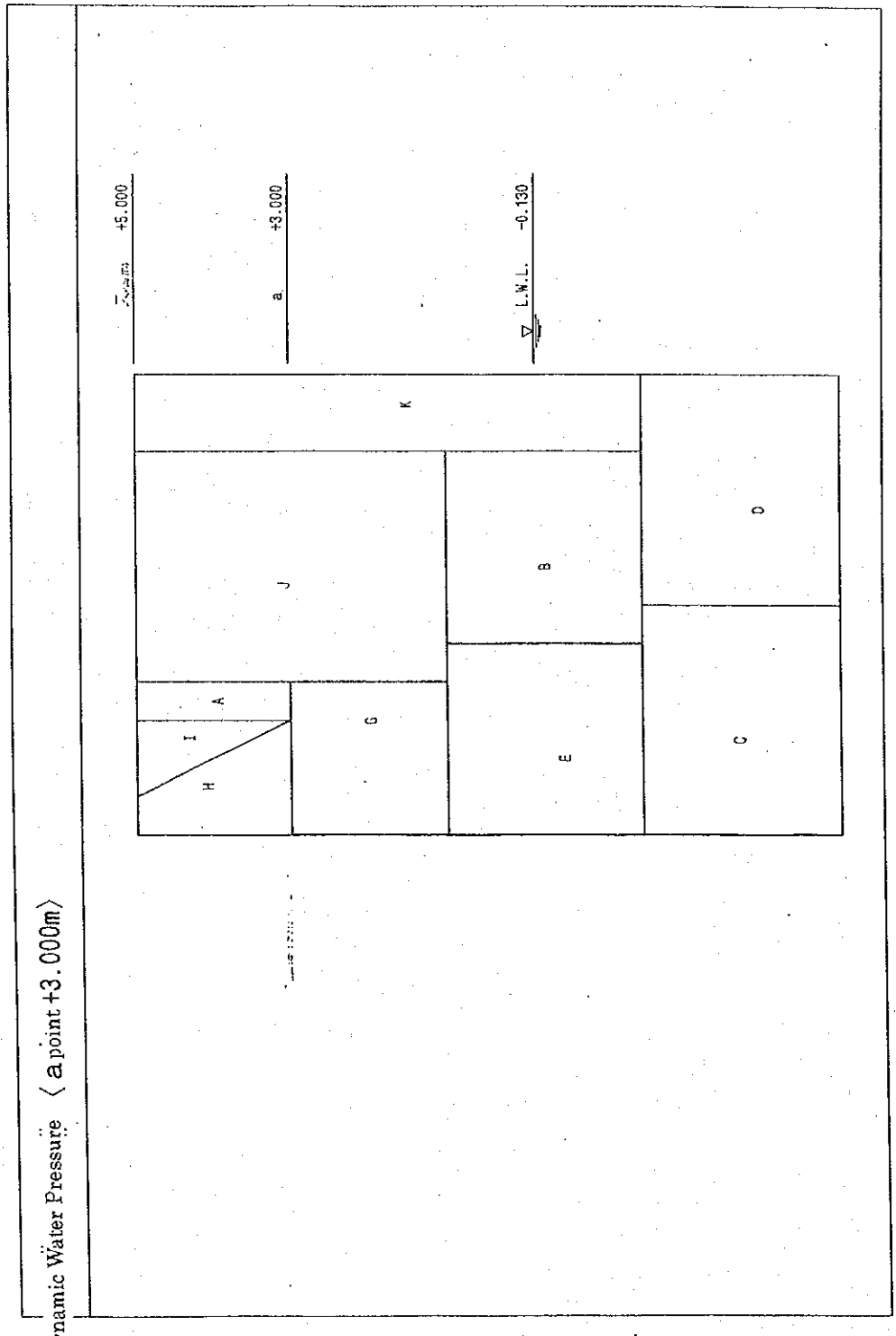
$$P_{2'} = \frac{7}{12} \times 0.200 \times 10.100 \times \sqrt{3.870} \times 3.870^{1/1} = 17.648 \ (kN/m)$$

$$h_{2'} = \frac{2}{5} \times 3.870 = 1.548 \ (m)$$

$$M_3 = 17.648 \times 1.548 = 27.319 \ (kN \cdot m/m)$$

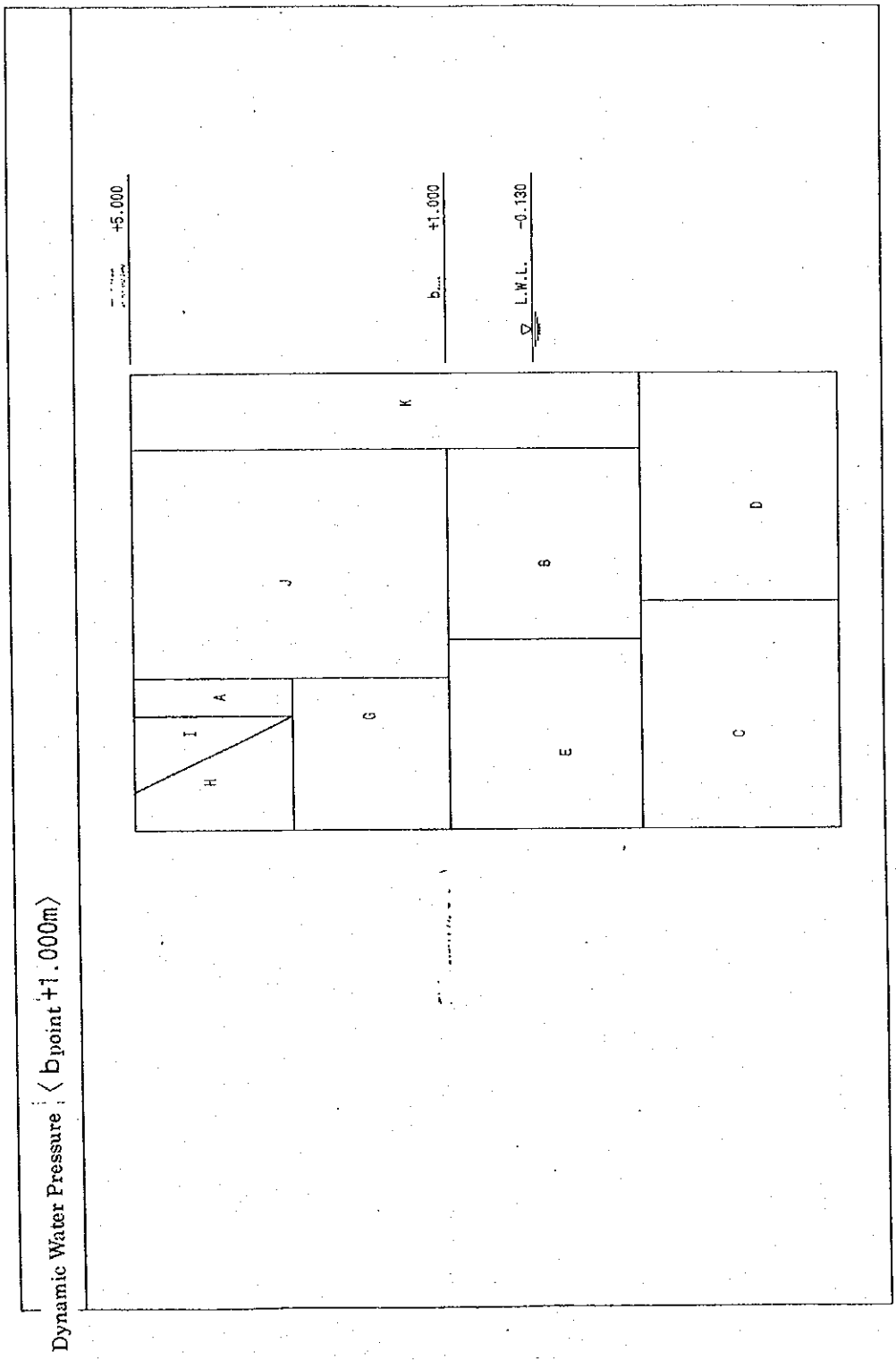
		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 33	Rev.



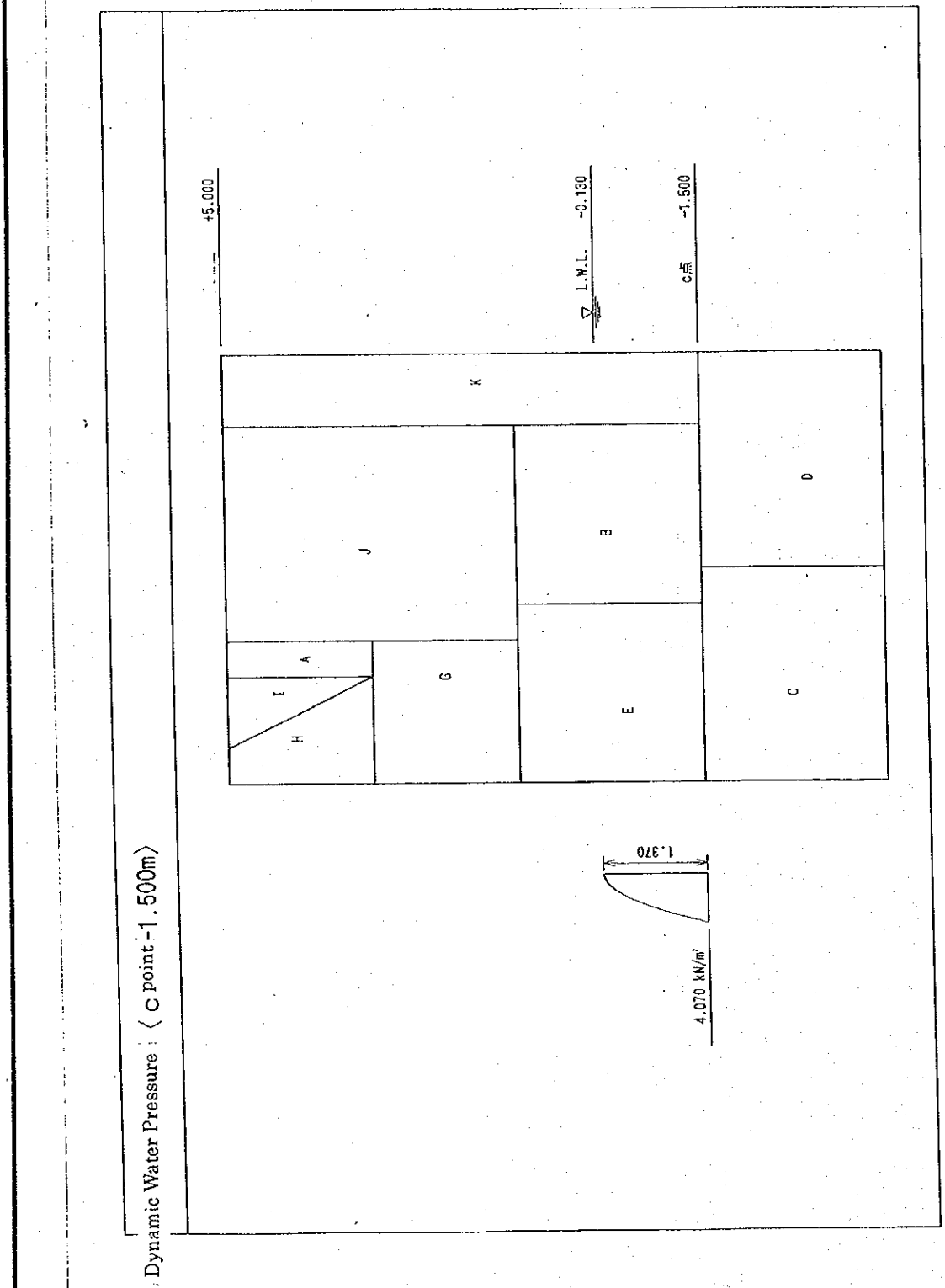
		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 34	Rev.



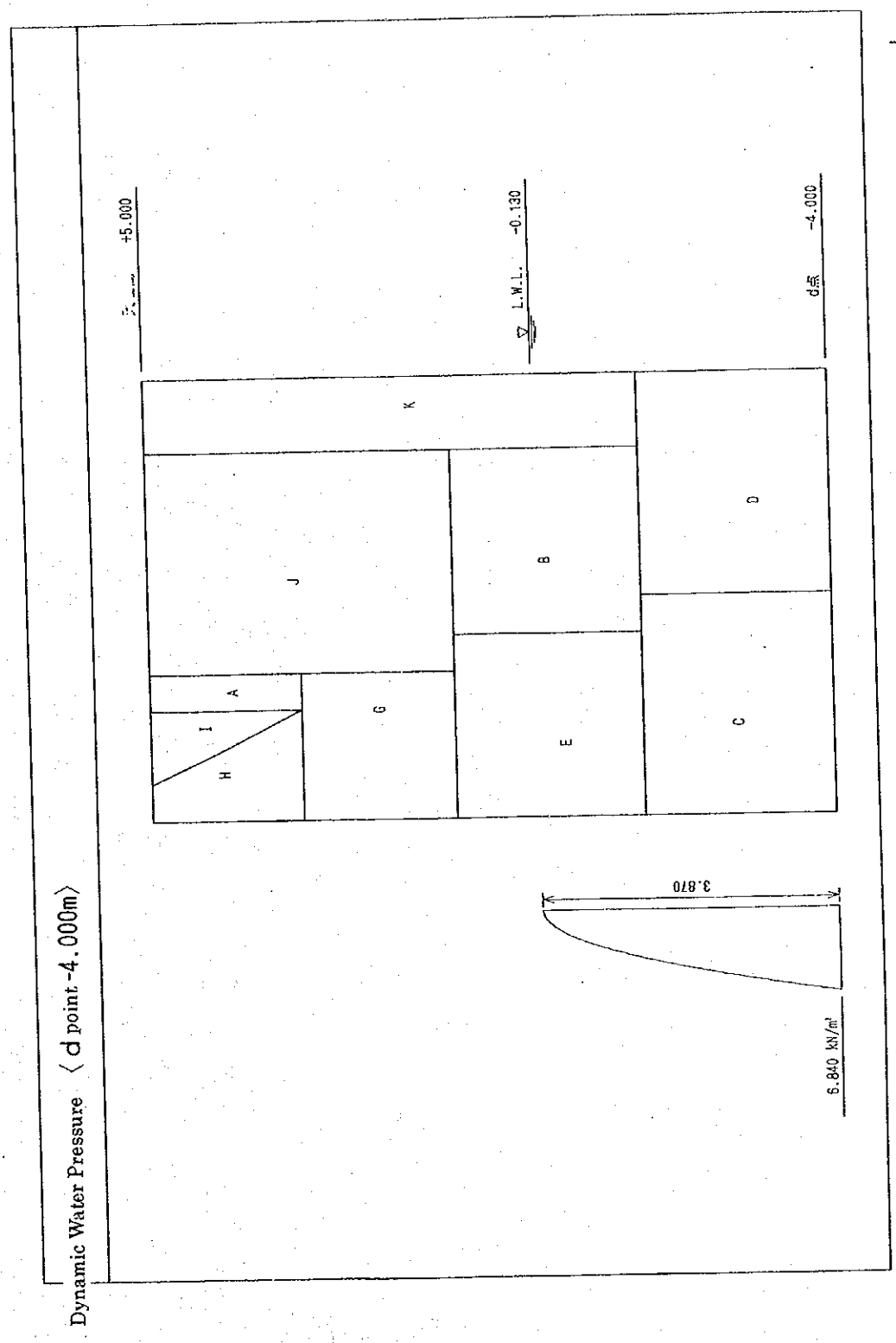
		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 35	Rev.



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 36	Rev.



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

FN: Calculation_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 37	Rev.

3-3. Weight of Wall

[1] Horizontal Seismic Force and Moment

A, < 3.000m >

No	Name	W (kN/m)	K_h	W_h (kN/m)	y (m)	M_{oh} (kN·m/m)
1	A1	46.000	0.200	9.200	0.834	7.673
2	AS	20.000	0.200	4.000	1.333	5.332
Total				13.200		13.005

B, < 1.000m >

No	Name	W (kN/m)	K_h	W_h (kN/m)	y (m)	M_{oh} (kN·m/m)
1	A2	20.000	0.200	4.000	3.000	12.000
2	B1	92.000	0.200	18.400	1.000	18.400
3	A1	46.000	0.200	9.200	2.834	26.073
4	AS	20.000	0.200	4.000	3.333	13.332
Total				35.600		69.805

C, < -1.500m >

No	Name	W (kN/m)	K_h	W_h (kN/m)	y (m)	M_{oh} (kN·m/m)
1	A2	20.000	0.200	4.000	5.500	22.000
2		143.750	0.200	28.750	1.250	35.938
3	C1	143.750	0.200	28.750	1.250	35.938
4	B1	92.000	0.200	18.400	3.500	64.400
5	A1	46.000	0.200	9.200	5.334	49.073
6	AS	20.000	0.200	4.000	5.833	23.332
7	BS	240.000	0.200	48.000	4.500	216.000
Total				141.100		446.681

D < -4.000m >

No	Name	W (kN/m)	K_h	W_h (kN/m)	y (m)	M_{oh} (kN·m/m)
1	A2	20.000	0.200	4.000	8.000	32.000
2		143.750	0.200	28.750	3.750	107.812
3	D1	172.500	0.200	34.500	1.250	43.125
4	D2	172.500	0.200	34.500	1.250	43.125
5	C1	143.750	0.200	28.750	3.750	107.812
6	B1	92.000	0.200	18.400	6.000	110.400
7	A1	46.000	0.200	9.200	7.834	72.073
8	AS	20.000	0.200	4.000	8.333	33.332
9	BS	240.000	0.200	48.000	7.000	336.000
10	CS	130.000	0.200	26.000	5.750	149.500
Total				236.100		1035.179

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 38	Rev.

3-5. Stability of Wall

[1] Sliding

$$F = \frac{\mu \cdot V}{H}$$

[2] Overturning

$$F = \frac{M_t}{M_o}$$

V : Total Vertical Force (kN/m) (kN/m)
H : Total Horizontal Force (kN/m) (kN/m)
μ : Coefficient of Friction
M_t : Moment of Total Vertical force (kN·m/m)
M_o : Moment of Total Horizontal Force (kN·m/m)

A < 3.000m >

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_o (kN·m/m)
Earth Pressure	4.560	17.014	6.840	13.346
Residual Water Pressure		0.000		0.000
Weight of Wall	66.000	13.200	48.272	13.005
Buoyancy Total	0.000		0.000	
Dynamic Water Pressure		0.000		0.000
Total	70.560	30.214	55.112	26.351

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F	Allowable Values	
$\frac{0.500 \times 70.560}{30.214}$	1.167	≧1.00	$\frac{55.112}{26.351}$	2.091	≧1.10

P < 1.000m >

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_o (kN·m/m)
Earth Pressure	15.023	56.059	30.046	82.730
Residual Water Pressure		0.005		0.000
Weight of Wall	178.000	35.600	175.272	69.805
Buoyancy Total	-0.660		-0.660	
Dynamic Water Pressure		0.000		0.000
Total	192.363	91.664	204.658	152.535

Sliding			Overturning		
Safety Factor F	Allowable Values		Safety Factor F	Allowable Values	
$\frac{0.500 \times 192.363}{91.664}$	1.049	≧1.00	$\frac{204.658}{152.535}$	1.341	≧1.10

	Prepared by	Y.Ando	Checked by	R.Nisimura
		26/07/2002		26/07/2002

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Subject	Revetment	Page No. 39	Rev.

C/ < -1.500m

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_o (kN·m/m)
Earth Pressure	35.608	132.867	178.040	312.922
Residual Water Pressure		22.922		23.030
Weight of Wall	705.500	141.100	1734.022	446.681
Buoyancy Total	-126.650		-316.625	
Dynamic Water Pressure		3.717		2.037
Total	614.458	300.606	1595.437	784.670

Sliding			Overturning		
Safety Factor F		Allowable Values	Safety Factor F		Allowable Values
0.500 x 614.458 / 300.606	1.022	≧1.00	1595.437 / 784.670	2.033	≧1.10

D. < -4.000m >

	V (kN/m)	H (kN/m)	M_t (kN·m/m)	M_o (kN·m/m)
Earth Pressure	63.995	238.788	383.970	771.767
Residual Water Pressure		52.287		117.041
Weight of Wall	1180.500	236.100	3484.022	1035.179
Buoyancy Total	-301.980		-905.940	
Dynamic Water Pressure		17.648		27.319
Total	942.515	544.823	2962.052	1951.306

Sliding			Overturning		
Safety Factor F		Allowable Values	Safety Factor F		Allowable Valu
0.600 x 942.515 / 544.823	1.037	≧1.00	2962.052 / 1951.306	1.517	≧1.10

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

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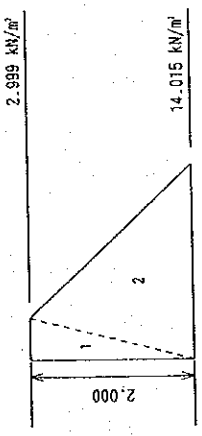
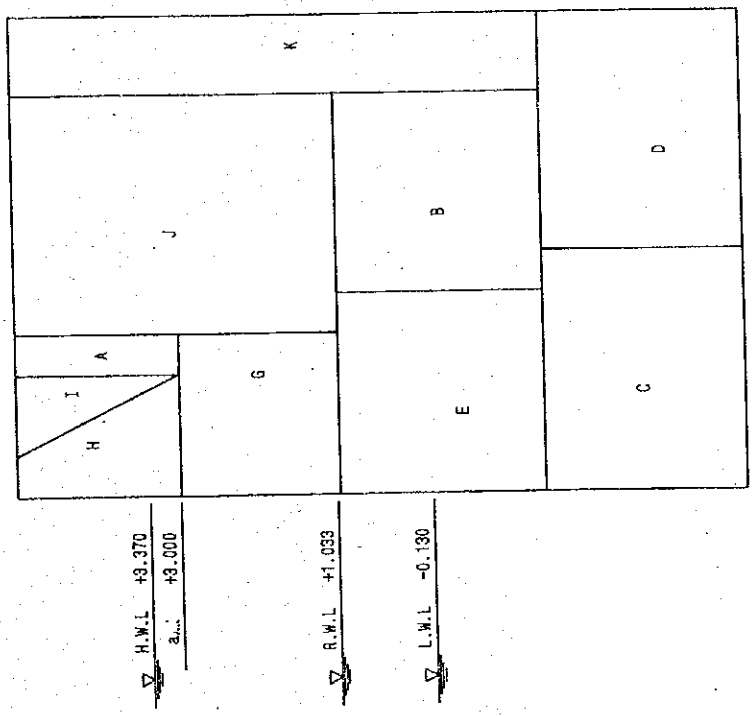
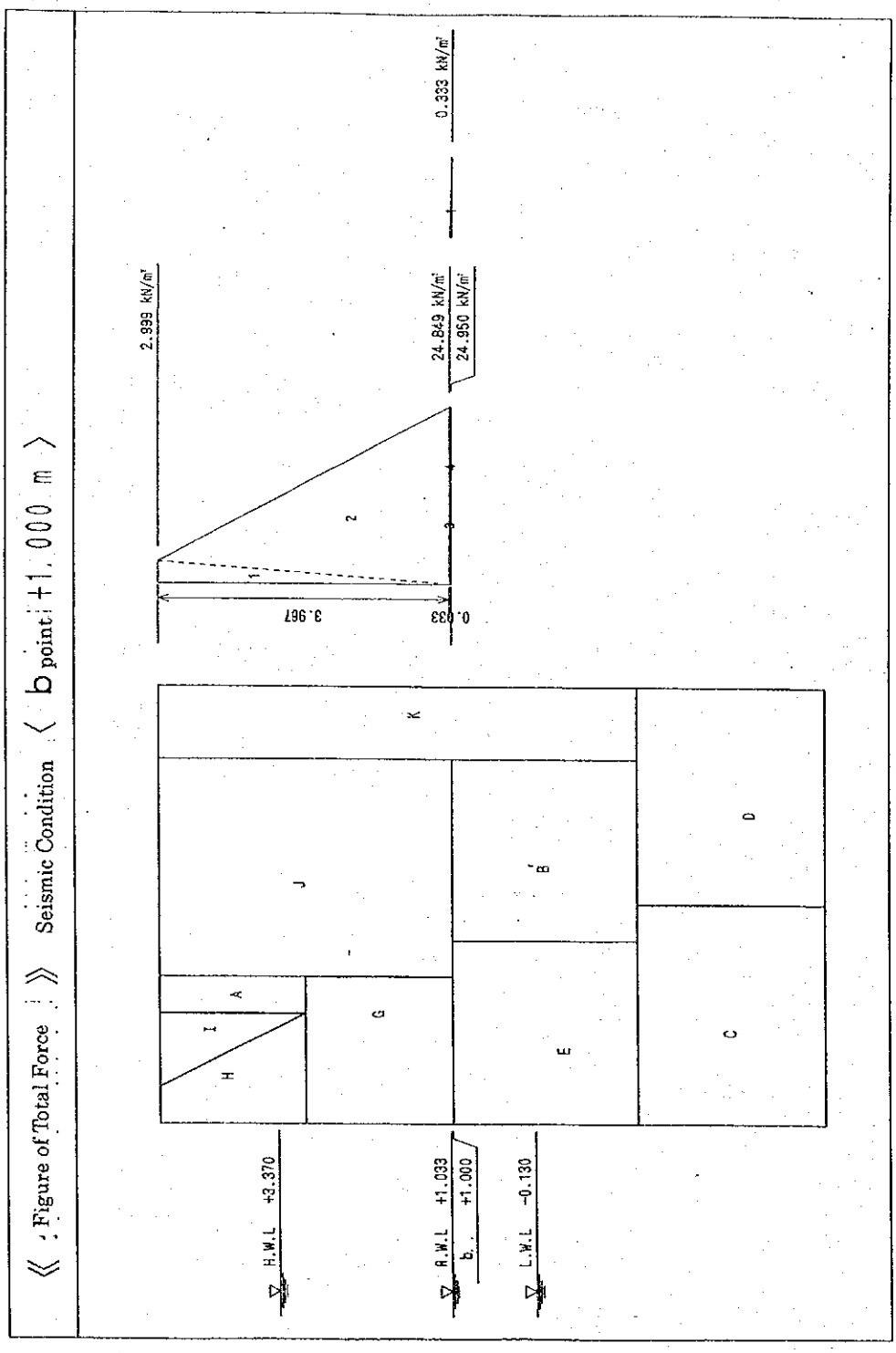
《 Figure of Total Force 1 》 Seismic Condition 〈 a point +3.000 m 〉





		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

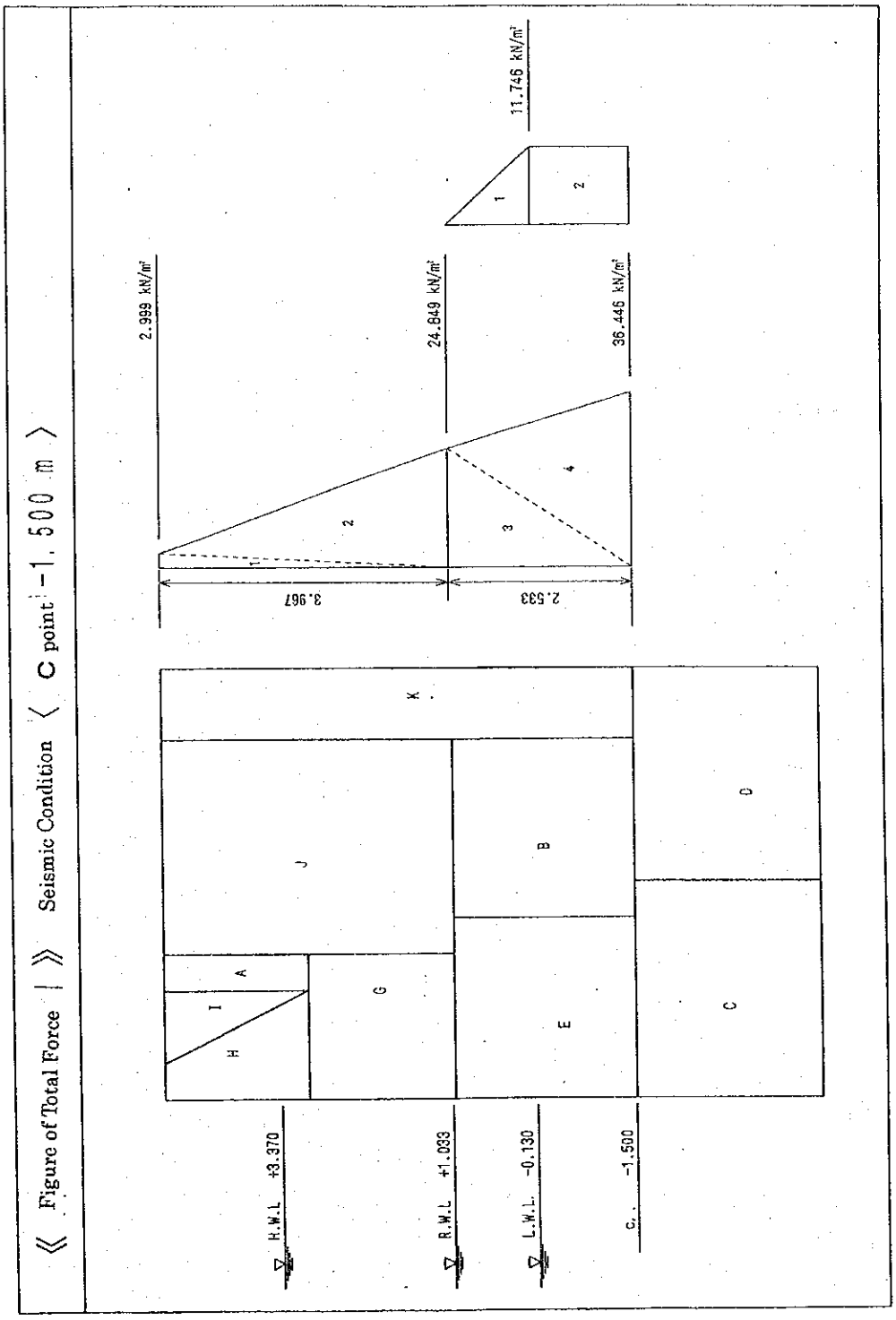
Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 81	Rev.



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 42	Rev.

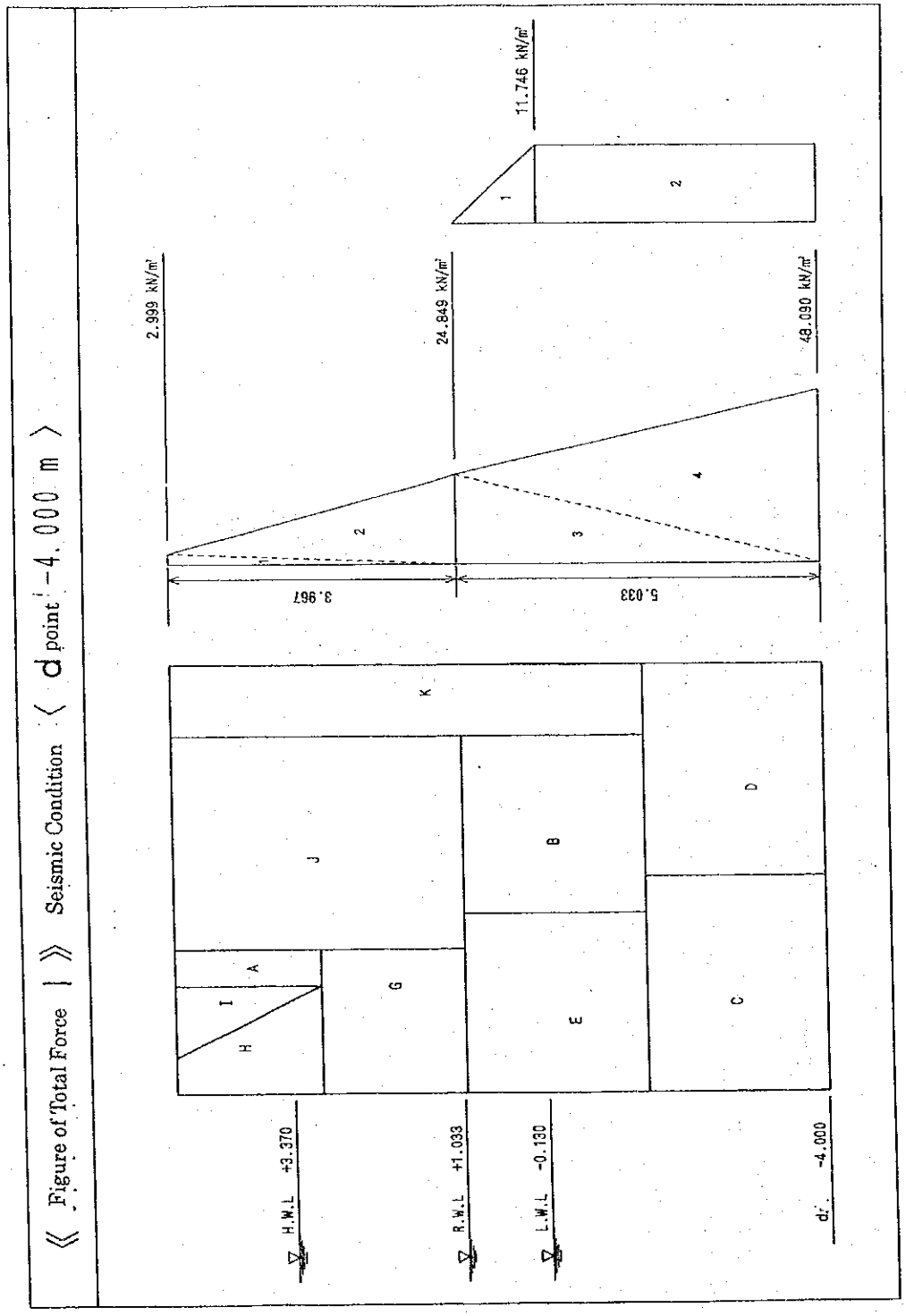
《 Figure of Total Force 1 》 Seismic Condition 〈 C point -1.500 m 〉



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 43	Rev.

《 Figure of Total Force 》 Seismic Condition 〈 d point -4.000 m 〉



		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Revetment	Page No. 44	Rev.

3-6. Bearing Capacity

[1] Reaction of Bottom Surface of Block

a) $0 < e \leqq b/6$

$$p_1 = \left(1 + \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b}$$

$$p_2 = \left(1 - \frac{6 \cdot e}{b}\right) \cdot \frac{V}{b}$$

b) $e > b/6$

$$p_1 = \frac{2}{3} \cdot \frac{V}{x}$$

$$p_2 = 0$$

$$b' = 3 \cdot x$$

c) $e < 0$ の

$$p = \frac{V}{b}$$

$$x = \frac{M_1 - M_0}{V} \qquad e = \frac{b}{2} - x$$

p_1 : Maximum Reaction Force } (kN/m²)
p_2 : Minimum Reaction Force } (kN/m²)
b : Width of Wall (m)
V : Vertical resultant force act on wall (kN/m)
b' : Distribution width of bottom reactions in case e>b/6 (m)
M_1 : Moment of Vertical force act on wall (kN·m/m)
M_0 : Moment of Horizontal force act on wall (kN·m/m)
e : Eccentricity of resultant force of Vertical and Horizontal (m)

$$x = \frac{M_1 - M_0}{V} = \frac{2962.052 - 1951.306}{942.515} = 1.072 \text{ (m)}$$

$$e = \frac{b}{2} - x = \frac{6.000}{2} - 1.072 = 1.928 \text{ (m)}$$

b) e > b／6の場合

$$p_1 = \frac{2 \cdot V}{3 \cdot x} = \frac{2x\ 942.515}{3x\ 1.072} = 586.142 \text{ (kN/m²)}$$

$$b' = 3 \cdot x = 3x\ 1.072 = 3.216 \text{ (m)}$$

$$p_2 = 0$$

Maximum Reaction Force < Allowable Bearing Capacity of Rubble Mound

586.142 (kN/m²) ≦ 600.000 (kN/m²) ..... OK

		Prepared by	Y.Ando	Checked by	R.Nisimura
			26/07/2002		26/07/2002

DESIGN CALCULATION COVER SHEET

Project	Detailed Design on Port Reactivation Project in La Union Province	**Project Code**	JC1N004
Section	**Civil**	Calc. File No.	
Sub-Section	**Road and Pavement**	Calc. Index No.	

Subject:

Design of Concrete Pavement

Calculation Objective:

- To analyze and check a thickness of pavement which includes subbase course, base course and concrete pavement.
- To determine the bar-arrangement for concrete pavement

References, Calculation Notes and Comments

Refer to next page

Rev	Prepared		No. of Pages	Checked		Reviewed		Superseded by Calc No.
	by	Date		by	Date	by	Date	
O	Carlo	July 18	9	for ST	28 July 02		8/18/02	
A								
B								
C								

File in Calc. File

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Road and Pavement	Page No. /	Rev.

References/ Notes

1. Design General

This examination carries out for the purpose of determining dimension of concrete pavement. The target facility is shown below.

R.T.G Lane (Target Machine : R.T.G)

Chassis Lane (Target Machine : Forklift Truck)

2. Design Condition

1) Compliant Standard

「TECHNICAL STANDARDS AND COMMENTARIES FOR PORT AND HARBOUR FACILITIES IN JAPAN」

2) Design Bearing Capacity Coefficient (K_{30}) of Subgrade and Base Course

(1) Design Bearing Capacity Coefficient (K_{30}) of Subgrade

Design Bearing Capacity Coefficient of Subgrade : $K_{30} = 70$ N/cm^3

(2) Design Bearing Capacity Coefficient (K_{30}) of Base Course

Design Bearing Capacity Coefficient of Base Course : $K_{30} = 200$N/cm^3

3) Material

(1) Concrete

Elastic modulus : E=3,500,000 (N/cm^2)

Poisson's ratio : υ =0.15

Bearing Strength : σ =450 N/cm^2 (2 8 days)

3) Design Load

(1) R.T.G

Maximum Wheel Load P = 250 kN / wheel

Radius of ground contact area a = 30.1 cm

(2) Forklift truck

Maximum Wheel Load P = 170 kN / wheel

Radius of ground contact area a = 27.1 cm

		Prepared by		Checked by	
			July 18 2002		19 07 2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Road and Pavement	Page No. 2	Rev.
		References/ Notes	

3. Design of Base Course

Base course thickness is determined using the following tables.

Design condition	Base course thickness (cm)				
Design bearing capacity coefficient K_{30} of subgrade (N/cm^3)	Base course		Subbase course		Total base course thickness
	Cement stabilization	Grading adjusted material	Grading adjusted material	Crusher run etc.	
Equal to or above 50 and less than 70	—	40	—	20	60
	20	—	20	—	40
	25	—	—	30	55
Equal to or above 70 and less than 100	—	20	15	—	35
	—	20	—	20	40
	15	—	15	—	30
	15	—	—	15	30
Equal to or above 100	—	20	—	—	20
	15	—	—	—	15

Base course shall use the following material.

Base course : Cement stabilization

Subbase course : Grading adjusted material

Therefore, each base course thickness is carried out as follows from the upper table.

Base course (Cement stabilization) : 15 cm

Subbase course (Grading adjusted material) : 15 cm

	Prepared by		Checked by	
		July 18 2002		19 07 2002

FN: Calculation_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Road and Pavement	Page No. 3	Rev.

References/ Notes

4. Design of Concrete Slab

Concrete slab thickness is set up from the following table. The examination of stress of concrete slab is performed using set-up concrete slab thickness.

(1) Setup of concrete slab thickness

Classification of design load	Type of load		Load (kN)	Radius of contact area (cm)
CP_1	Forklift truck	(2t)	25	9.8
	Tractor-trailer	(for 20-ft and 40-ft)	50	17.8
	Forklift truck	(3.5t)	45	12.6
CP_2	Tractor-trailer	(for 40-ft yard use only)	70	17.8
	Forklift truck	(6t)	70	16.0
CP_3	Truck	(T-25)	100	17.8
	Forklift truck	(10t)	110	21.1
	Straddle carrier		110	19.5
	Forklift truck	(15t)	170	27.1
CP_4	Transfer crane	(20t)	200	17.6
	Truck crane	(25 Type)	200	20.0
	Forklift truck	(20t)	240	31.7
	Truck crane	(25 Type)	250	21.6

Table - Design Loads by Classification

Design load classification	Slab thickness (cm)
CP_1	20
CP_2	25
CP_3	30
CP_4	35
On the deck slab of open-type wharf	10

Table - Concrete Slab hickness

・Design Load by Classification

R.T.G P=250kN/wheel a=30.1cm → CP_4

Forklift truck P=170kN/wheel a=27.1cm → CP_3

・Setup of concrete slab thickness

R.T.G Lane : 35cm

Chassis Lane : 30cm

Amb July/18/2002

Checked by Y. Ando 19/07/2002

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(2) Examination of Stress of Concrete Slab

The stress of the concrete slab computed by the following formulas checks that it is less than bending strength of concrete.

$$\sigma = \frac{10 \times C \times P}{h^2} \times \left(1 - \frac{\sqrt{\frac{a}{l}}}{0.925 + 0.22 \times \frac{a}{l}}\right)$$

C : coefficient; when slip bars are used, C=3.36 may be used

P : load (kN)

h : thickness of concrete slab (cm)

a : radius of ground contact area (cm)

l : radius of relative stiffness of the pavement (cm)

$$l = \sqrt[4]{\frac{E \times h^3}{12 \times (1 - \upsilon^2) \times K_{75}}}$$

E : elastic modulus of concrete (=3,500,000 N/cm^2)

υ : Poisson's ratio of concrete (=0.15)

K_{75} : design bearing capacity coefficient of base course

(K_{30}/K_{75}=2.8 $K_{75}=K_{30}/2.8 = 200/2.8 \fallingdotseq 70$ (N/cm^3)

1) R.T.G Lane

$$l = \sqrt[4]{\frac{3{,}500{,}000 \times 35^3}{12 \times (1-0.15^2) \times 70}} = 116.27 \text{ cm}$$

$$\sigma = \frac{10 \times 3.36 \times 250}{35^2} \times \left(1 - \frac{\sqrt{\frac{30.10}{116.27}}}{0.925 + 0.22 \times \frac{30.10}{116.27}}\right) = 3.304 \text{ N/mm}^2$$

$= 330.4 \text{ N/cm}^2 \leqq 450.0 \text{ N/cm}^2$ O.K

2) Chassis Lane

$$l = \sqrt[4]{\frac{3{,}500{,}000 \times 30^3}{12 \times (1-0.15^2) \times 70}} = 103.58 \text{ cm}$$

$$\sigma = \frac{10 \times 3.36 \times 170}{30^2} \times \left(1 - \frac{\sqrt{\frac{27.10}{103.58}}}{0.925 + 0.22 \times \frac{27.10}{103.58}}\right) = 3.043 \text{ N/mm}^2$$

$= 304.3 \text{ N/cm}^2 \leqq 450.0 \text{ N/cm}^2$ O.K

Gude July 18 12002

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4. Determination of Structure of Joint

Based on a standard, the structure of joint is determined as follows.

1) R.T.G Lane

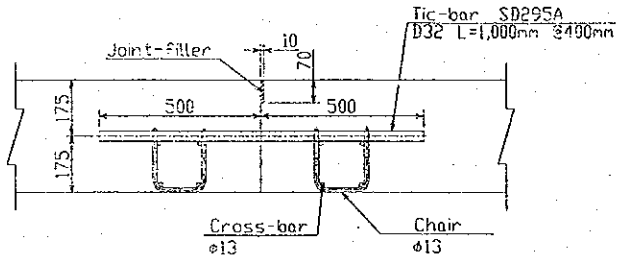
(1) Longitudinal Joint

Longitudinal Joint should be butt joint with tie-bars.

The dimension of tie-bar is as follows and an installation interval is set to 40cm.

Type of Steel : SD295A 、Diameter : D32 、Length : L = 100cm

Structure figure is shown below.



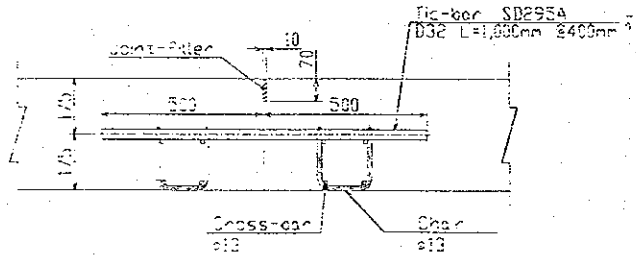
(2) Transverse Joint

The transverse joint is used as the contraction joint, and let structure be dummy joint with slip-bars.

The dimension of slip-bar is as follows and an installation interval is set to 40cm.

Type of steel : SS400 、Diameter : φ 32 、Length : L = 60cm

Structure figure is shown below.



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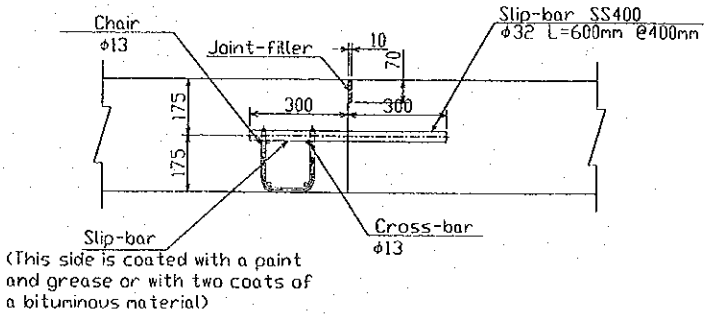
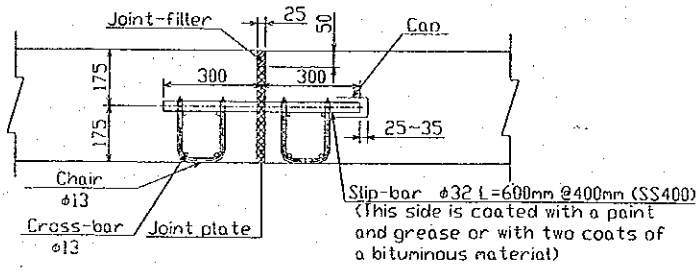
When preparing the transverse construction joint, structure is butt joint with slip-bars.

Dimension of slip bar is taken as the same thing as the transverse contraction joint. Structure figure is shown below.



A transverse expansion joint has the structure that comprises a joint-filler at surface, a joint plate at bottom, and slip-bars. Dimension of slip bar is taken as the same thing as the transverse contraction joint. As expansion joints constitute the serious weak point of pavement, the number of such joints should be made as small as possible. Structure figure is shown below.



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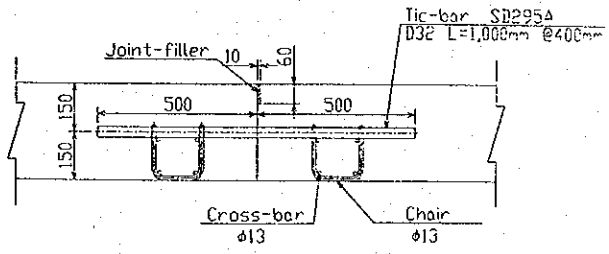
2) Chassis Lane

The structure form of joint and the dimension of tie-bars and slip-bars of chassis lane are taken as the same thing as the thing of an R.T.G lane.

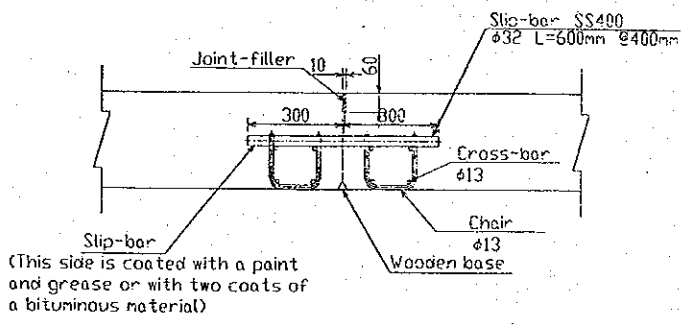
(1) Longitudinal Joint

Structure figure is shown below.

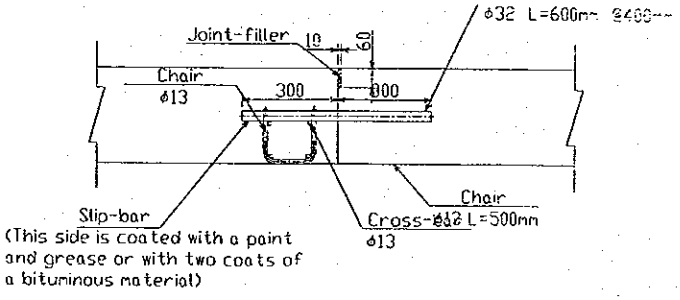


(2) Transverse Joint

Structure figure is shown below.



The structure figure of the transverse construction joint is shown below.



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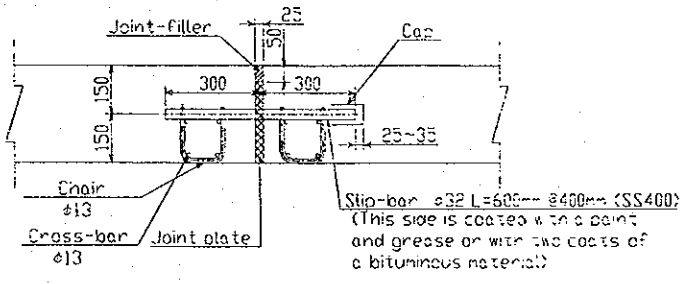
The structure figure of the transverse expansion joint is shown below.



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5. Iron Mesh

The area of reinforcement of Iron mesh makes 30N a standard per $1m^2$.

Material uses deformed bar "D6".

A reinforcing bar is arranged in the two directions so that it may intersect perpendicularly, and it sets an interval to 150mm.

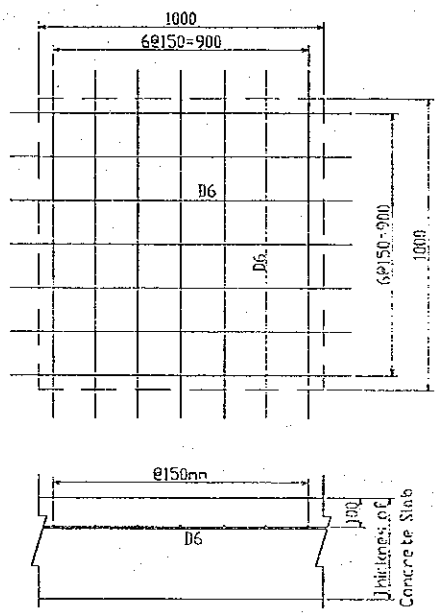
Reinforcing bars number per $1m^2$ N=14

Weight per unit length of reinforcing bar "D6" 0.249 kg/m

Reinforcing bars weight per $1m^2$ $W=0.249\times1.0\times14=3.49$ kg = 34.2 N

An arrangement position is set to 10cm from the surface. Length of lap splices may be 15cm.

A structure outline figure is shown below.



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DESIGN CALCULATION COVER SHEET

Project	Detailed Design on Port Reactivation Project in La Union Province	**Project Code**	JC1N004
Section	**Civil**	Calc. File No.	
Sub-Section	**Storm Drainage**	Calc. Index No.	

Subject:

Determination of Size and Slope for Trench

Calculation Objective:

To analyze and check a size hydaulic grade line, discharge volume and velocity of trench from each of cathment area in the port area.

References, Calculation Notes and Comments

Design Condition

1) Velocity within pipe : Maximum 3 m/s

2) Roughhness Coefficient : 0.014 (Concrete Pipe)

3) Run-off Coefficient : C

Concrete Pavement : 0.85, Asphalt Pavement : 0.80, Macadam Pavement : 0.70

Cutting Area : 0.05

4) Design Rainfall Intensity : 135 mm /h

5) Calculation Model : Manning Formula

$Q = A \times 1/n \times R^{2/3} \times I^{1/2}$

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	by	Date	Pages	by	Date	by	Date	by Calc No.
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A								
B								
C								

File in Calc. File

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CALCULATIONS FOR STORMWATER DRAIN…GE (Pipe Culvert)

Diamater of Pipe Culvert ;

Inchs	18	24	30	36	48	60	72
mm	457	610	762	914	1219	1524	1829

Roughness Coefficient n 0.013

	Required Discharging Water Volume									Pipe Culvert								
	Catchment Area (ha)				C	I	Q (m3/sec)		Remark	Culvert	Length (m)	Elevation (Inlet)	Bottom elevation of culvert	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
A																		
A-2	80	20	0.160	0.160	0.85	135.0	0.051	0.051		AP-1	20.00	+5.532	+4.222	0.20	+4.182	0.610	0.971	0.284
A-2-1	10	35	0.035	0.035	0.5	135.0	0.007	0.058		AP-2	40.00	+5.532	+4.222	0.20	+4.142	0.610	0.971	0.284
A-1'	26	40	0.104	0.104	0.85	135.0	0.033	0.091		AP-3	26.00	+5.332	+4.022	0.10	+3.996	0.610	0.687	0.201
A-1	70	40	0.280	0.280	0.85	135.0	0.089											
A-3	Trapezoid		0.188	0.188	0.5	135.0	0.035											
A-4	5	52	0.023	0.023	0.8	135.0	0.007	0.222		AP-4	85.78	+5.332	+4.022	0.20	+3.850	0.610	0.971	0.284
A-5	Trapezoid		0.276	0.276	0.7	135.0	0.072											
A-6	86	36	0.155	0.155	0.7	135.0	0.041											
A-7	26	86	0.224	0.224	0.85	135.0	0.071	0.071		AP-5-1	26.00	+5.126	+4.016	0.10	+3.990	0.610	0.687	0.201
A-8	5	86	0.019	0.019	0.8	135.0	0.006	0.412		AP-5	87.49	+5.126	+3.864	0.20	+3.689	0.762	1.135	0.517
A-9	89	58	0.258	0.258	0.7	135.0	0.068											
A-16	5	91	0.041	0.041	0.8	135.0	0.012											
A-18	60	216	0.648	0.648	0.5	135.0	0.122	0.134		AP-6-1	26.00	+4.923	+3.813	0.10	+3.787	0.610	0.687	0.201
A-10	50	91	0.226	0.226	0.7	135.0	0.059	0.122		AP-6-2	12.65	+4.928	+2.207	0.10	+2.194	0.610	0.687	0.201
A-11	31	91	0.276	0.276	0.8	135.0	0.083											
A-12	92	38	0.175	0.175	0.7	135.0	0.046	0.802		AP-6	93.60	+4.923	+3.509	0.20	+3.322	0.914	1.273	0.835
A-15	26	91	0.236	0.236	0.85	135.0	0.075	0.075		AP-7-1	26.00	+4.711	+3.601	0.10	+3.575	0.610	0.687	0.201
A-13	91	46	0.208	0.208	0.7	135.0	0.055											
A-14	92	54	0.248	0.248	0.7	135.0	0.065											
A-17	96	29	0.277	0.277	0.85	135.0	0.088	1.085		AP-7	28.90	+4.711	+2.992	0.15	+2.949	1.219	1.335	1.557
B																		
B-1	101	12	0.061	0.061	0.5	135.0	0.011											
B-2	85	6	0.026	0.026	0.85	135.0	0.008											
B-3	121	17	0.103	0.103	0.85	135.0	0.033											
B-6	89	36	0.160	0.160	0.7	135.0	0.042	0.134		BP-1-1	26.00	+5.332	+4.022	0.20	+3.970	0.610	0.971	0.284
B-4	160	36	0.576	0.576	0.85	135.0	0.184											
B-5	91	36	0.164	0.164	0.7	135.0	0.043	0.321		BP-1	85.78	+5.332	+3.870	0.20	+3.698	0.762	1.135	0.517
B-7	37	86	0.159	0.159	0.7	135.0	0.042											
B-8	91	53	0.241	0.241	0.7	135.0	0.063											
B-9	77	38	0.146	0.146	0.7	135.0	0.038	0.143		BP-2-1	26.00	+5.126	+3.816	0.20	+3.764	0.610	0.971	0.284
B-10	25	86	0.215	0.215	0.8	135.0	0.065											

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CALCULATIONS FOR STORMWATER DRAI GE (Pipe Culvert)

Diamater of Pipe Culvert :

Inchs	18	24	30	36	48	60	72
mm	457	610	762	914	1219	1524	1829

Roughness Coefficient n 0.013

Required Discharging Water Volume										Pipe Culvert								
Catchment Area (ha)					C	I	Q (m3/sec)		Remark	Culvert	Length (m)	Elevation (Inlet)	Bottom elevation of culvert	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
B-11	49	86	0.211	0.211	0.7	135.0	0.055											
B-12	89	53	0.236	0.236	0.7	135.0	0.062											
B-13	70	36	0.126	0.126	0.7	135.0	0.033	0.679		BP-2	87.49	+5.126	+3.512	0.20	+3.337	0.914	1.273	0.835
B-14	52	91	0.235	0.235	0.7	135.0	0.062											
B-15	77	58	0.223	0.223	0.7	135.0	0.059											
B-16	81	38	0.154	0.154	0.7	135.0	0.040	0.161		BP-3-1	26.00	+4.923	+3.413	0.20	+3.361	0.610	0.971	0.284
B-17	25	91	0.226	0.226	0.85	135.0	0.072											
B-18	64	91	0.290	0.290	0.7	135.0	0.076											
B-19	74	58	0.215	0.215	0.7	135.0	0.056											
B-20	77	38	0.146	0.146	0.7	135.0	0.038	1.083		BP-3	93.60	+4.923	+2.804	0.15	+2.664	1.219	1.335	1.557
B-21	47	91	0.213	0.213	0.7	135.0	0.056											
B-22	81	54	0.219	0.219	0.7	135.0	0.057	0.113		BP-5-1	6.00	+4.711	+2.492	0.20	+2.480	1.219	1.542	1.798
B-23	25	91	0.227	0.227	0.85	135.0	0.072											
B-24	60	91	0.272	0.272	0.7	135.0	0.071											
B-25	77	54	0.208	0.208	0.85	135.0	0.066											
B-26	160	29	0.462	0.462	0.85	135.0	0.147	1.422		BP-4	20.00	+4.711	+2.492	0.20	+2.452	1.219	1.542	1.798
								1.553		BP-5	28.90	+4.711	+2.492	0.20	+2.434	1.219	1.542	1.798
C																		
C-G	43	22	0.095	0.095	0.9	135.0	0.032	0.032		CP-1	17.00	+5.632	+4.275	0.20	+4.241	0.457	0.802	0.131
C-A-1	50	30	0.038	0.038	0.9	135.0	0.013	0.045		CP-2	20.00	+5.632	+4.275	0.20	+4.235	0.457	0.802	0.131
C-A-2								0.045		CP-3	35.00	+5.632	+4.275	0.20	+4.205	0.457	0.802	0.131
C-A-3	50	30	0.038	0.038	0.9	135.0	0.013	0.013		CP-4-1	20.00	+5.632	+4.275	0.20	+4.235	0.457	0.802	0.131
C-A-4								0.057		CP-4	20.00	+5.632	+4.275	0.20	+4.235	0.457	0.802	0.131
C-M-1	55	25	0.069	0.069	0.9	135.0	0.023	0.023		CP-5-1	8.00	+5.632	+4.275	0.20	+4.259	0.457	0.802	0.131
C-M-2								0.080		CP-5	70.00	+5.632	+4.275	0.20	+4.135	0.457	0.802	0.131
C-M-3								0.080		CP-6	30.00	+5.632	+4.122	0.20	+4.062	0.610	0.971	0.284
C-R-1								0.080		CP-7	35.00	+5.632	+4.275	0.20	+4.205	0.457	0.802	0.131
C-A-5	50	30	0.038	0.038	0.9	135.0	0.013	0.013		CP-8-4	10.00	+5.632	+4.275	0.20	+4.255	0.457	0.802	0.131
C-A-6								0.013		CP-8-3	35.00	+5.632	+4.275	0.20	+4.205	0.457	0.802	0.131
C-A-7	50	30	0.038	0.038	0.9	135.0	0.013	0.013		CP-8-2-1	10.00	+5.632	+4.275	0.20	+4.255	0.457	0.802	0.131
C-A-8								0.025		CP-8-2	20.00	+5.632	+4.275	0.20	+4.235	0.457	0.802	0.131
C-M-4	55	25	0.069	0.069	0.9	135.0	0.023	0.023		CP-8-1-1	30.00	+5.632	+4.275	0.20	+4.215	0.457	0.802	0.131

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CALCULATIONS FOR STORMWATER DRAINAGE (Pipe Culvert)

Roughness Coefficient n 0.013

Diamater of Pipe Culvert ;

Inchs	18	24	30	36	48	60	72
mm	457	610	762	914	1219	1524	1829

Required Discharging Water Volume										Pipe Culvert								
Catchment Area (ha)					C	I	Q (m3/sec)		Remark	Culvert	Length (m)	Elevation (Inlet)	Bottom elevation of culvert	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
C-M-5								0.049		CP-8-1	68.00	+5.632	+4.275	0.20	+4.139	0.457	0.802	0.131
C-3'	50	42	0.210	0.210	0.7	135.0	0.055											
C-1'	82	65	0.189	0.189	0.75	135.0	0.053											
C-2'	122	30	0.092	0.092	0.8	135.0	0.027	0.265		CP-8	35.00	+5.632	+4.122	0.20	+4.052	0.610	0.971	0.284
								0.265		CP-9	26.00	+5.332	+3.822	0.20	+3.770	0.610	0.971	0.284
C-1	50	64	0.320	0.320	0.75	135.0	0.090											
C-2	90	36	0.324	0.324	0.85	135.0	0.103											
C-3	87	35	0.152	0.152	0.85	135.0	0.049	0.507		CP-10	85.78	+5.332	+3.918	0.20	+3.746	0.914	1.273	0.835
C-4	50	48	0.240	0.240	0.75	135.0	0.068											
C-5	70	49	0.172	0.172	0.75	135.0	0.048	0.048		CP-11-1	26.00	+5.126	+3.816	0.20	+3.764	0.610	0.971	0.284
C-6	22	86	0.189	0.189	0.85	135.0	0.060											
C-7	48	86	0.206	0.206	0.7	135.0	0.054											
C-8	87	53	0.231	0.231	0.7	135.0	0.061											
C-9	74	38	0.141	0.141	0.7	135.0	0.037	0.834		CP-11	87.49	+5.126	+3.207	0.15	+3.076	1.219	1.335	1.557
C-10	82	124	0.508	0.508	0.7	135.0	0.133											
C-11	141	78	0.550	0.550	0.5	135.0	0.103											
C-12	25	94	0.235	0.235	0.85	135.0	0.075	0.075		CP-12-1	26.00	+4.923	+3.413	0.20	+3.361	0.610	0.971	0.284
C-13	52	94	0.244	0.244	0.7	135.0	0.064											
C-14	74	54	0.200	0.200	0.7	135.0	0.052											
C-15	78	38	0.148	0.148	0.7	135.0	0.039											
C-16	172	39	0.335	0.335	0.5	135.0	0.063	1.364		CP-12	93.60	+4.923	+2.804	0.20	+2.617	1.219	1.542	1.798
C-17	182	54	0.491	0.491	0.5	135.0	0.092											
C-18	52	95	0.247	0.247	0.5	135.0	0.046											
C-19	25	91	0.227	0.227	0.85	135.0	0.072	0.072		CP-13-1	26.00	+4.711	+3.101	0.20	+3.049	0.610	0.971	0.284
C-20	50	91	0.227	0.227	0.7	135.0	0.059											
C-21	78	55	0.215	0.215	0.7	135.0	0.056											
C-22	93	29	0.269	0.269	0.85	135.0	0.086	1.776		CP-13	28.90	+4.711	+2.492	0.20	+2.434	1.219	1.542	1.798
D																		
D2-8	10	190	0.190	0.190	0.8	135.0	0.057	0.057		DP-1	129.19	+6.250	+5.293	0.50	+4.647	0.457	1.267	0.208
D2-7	10	152	0.152	0.152	0.85	135.0	0.048	0.105		DP-2	20.82	+5.500	+3.743	0.50	+3.639	0.457	1.267	0.208
D2-6	10	30	0.030	0.030	0.85	135.0	0.010	0.010		DP-3	24.13	+5.200	+3.443	0.10	+3.419	0.457	0.567	0.093
D2-5	20	60	0.060	0.060	0.85	135.0	0.019	0.019		DP-4-1	21.75	+5.340	+3.583	0.10	+3.561	0.457	0.567	0.093

Prepared by	Endo	Checked by	Y. Ando
	July/ 18 /2002		19/ 07 /2002

FN: Calculation_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
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References/

2002/7/217:20

CALCULATIONS FOR STORMWATER DRAINAGE (Pipe Culvert)

Diamater of Pipe Culvert ;

Inchs	18	24	30	36	48	60	72
mm	457	610	762	914	1219	1524	1829

Roughness Coefficient n 0.013

Required Discharging Water Volume										Pipe Culvert								
Catchment Area (ha)					C	I	Q (m3/sec)		Remark	Culvert	Length (m)	Elevation (Inlet)	Bottom elevation of culvert	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
D2-5	20	60	0.060	0.060	0.85	135.0	0.019	0.153		DP-4	160.00	+5.340	+4.230	0.10	+4.070	0.610	0.687	0.201
D2-4	60	35	0.210	0.210	0.8	135.0	0.063											
D2-3	75	12	0.090	0.090	0.8	135.0	0.027											
D2-2	160	13	0.208	0.208	0.8	135.0	0.062	0.152		DP-5-1	21.75	+5.340	+3.430	0.10	+3.408	0.610	0.687	0.201
D2-1	160	13	0.208	0.208	0.8	135.0	0.062	0.368		DP-5	37.88	+5.340	+3.926	0.10	+3.888	0.914	0.900	0.590
								0.368		DP-6	85.88	+4.632	+3.218	0.20	+3.046	0.914	1.273	0.835
D1-1	9	90	0.081	0.081	0.05	135.0	0.002	0.002		DP-7-1	18.25	+5.190	+3.433	0.10	+3.415	0.457	0.567	0.093
D1-2	9	90	0.081	0.081	0.05	135.0	0.002	0.371		DP-7	150.00	+5.190	+3.776	0.10	+3.626	0.914	0.900	0.590
D-3	268	50	0.670	0.670	0.05	135.0	0.013											
D-1	360	370	13.320	13.320	0.05	135.0	0.250	0.262		DP-8-1	90.00	+4.625	+3.211	0.10	+3.121	0.914	0.900	0.590
D-4	39	90	0.176	0.176	0.05	135.0	0.003											
D-5	268	40	0.536	0.536	0.05	135.0	0.010											
D-6	258	40	0.516	0.516	0.05	135.0	0.010	0.656		DP-8	90.00	+5.164	+3.750	0.15	+3.615	0.914	1.102	0.723
D1-3	9	90	0.081	0.081	0.05	135.0	0.002	0.002		DP-9-2	18.25	+5.010	+3.253	0.10	+3.235	0.457	0.567	0.093
D1-4	9	90	0.081	0.081	0.05	135.0	0.002	0.003		DP-9-1	150.00	+5.010	+4.053	0.10	+3.903	0.457	0.567	0.093
D-10	258	50	0.645	0.645	0.05	135.0	0.012											
D-11	50	90	0.225	0.225	0.05	135.0	0.004											
D-12	234	55	0.644	0.644	0.5	135.0	0.121	0.796		DP-9	130.50	+5.064	+3.345	0.15	+3.149	1.219	1.335	1.557
D-13	131	72	0.470	0.470	0.5	135.0	0.088											
D-14	192	78	0.749	0.749	0.5	135.0	0.140											
D-15	166	39	0.324	0.324	0.5	135.0	0.061	1.086		DP-10	90.60	+4.867	+3.148	0.15	+3.012	1.219	1.335	1.557
D-16	57	91	0.258	0.258	0.5	135.0	0.048											
D-17	166	54	0.448	0.448	0.5	135.0	0.084											
D-18	112	29	0.324	0.324	0.85	135.0	0.103	1.321		DP-11	28.90	+4.711	+2.192	0.20	+2.134	1.219	1.542	1.798
E																		
E-3	8	200	0.160	0.160	0.8	135.0	0.048	0.048		EP-4-4	22.00	+6.250	+5.293	0.50	+5.183	0.457	1.267	0.208
E-6	8	170	0.136	0.136	0.85	135.0	0.043	0.091		EP-4-3	142.69	+6.140	+5.183	0.50	+4.470	0.457	1.267	0.208
E-7	165	150	2.475	2.475	0.05	135.0	0.046											
E-8	165	17	0.281	0.281	0.05	135.0	0.005	0.143		EP-4-2	5.43	+5.430	+4.320	0.10	+4.315	0.610	0.687	0.201
E-1			5.015	5.015	0.05	135.0	0.094											
E-4	175	4	0.070	0.070	0.8	135.0	0.021	0.115		EP-1	20.00	+6.060	+5.103	0.48	+5.006	0.457	1.247	0.204
E-5	175	4	0.070	0.070	0.8	135.0	0.021	0.021		EP-2-1	9.10	+5.970	+4.213	0.10	+4.204	0.457	0.567	0.093
E-10	4	95	0.038	0.038	0.8	135.0	0.011	0.147		EP-2	81.47	+5.970	+5.013	0.48	+4.619	0.457	1.247	0.204

Prepared by	Endo	Checked by	Y. Ando
	July 1/8 /2002		/9/ 07 /2002

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Storm Drainage	Page No. 5	Rev.

References/ Notes

2002/7/217:20

CALCULATIONS FOR STORMWATER DRAINAGE (Pipe Culvert)

Diamater of Pipe Culvert ;

Inchs	18	24	30	36	48	60	72
mm	457	610	762	914	1219	1524	1829

Roughness Coefficient n 0.013

Required Discharging Water Volume										Pipe Culvert								
	Catchment Area (ha)				C	I	Q (m3/sec)		Remark	Culvert	Length (m)	Elevation (Inlet)	Bottom elevation of culvert	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
E-2	95	460	4.370	4.370	0.05	135.0	0.082	0.229		EP-3	55.01	+5.590	+4.480	0.48	+4.214	0.610	1.511	0.441
E-9	4	150	0.060	0.060	0.8	135.0	0.018	0.161		EP-4-1	9.10	+5.330	+3.420	0.10	+3.411	0.610	0.687	0.201
E-11	4	55	0.022	0.022	0.8	135.0	0.007											
E-12	4	16	0.006	0.006	0.8	135.0	0.002	0.399		EP-4	27.30	+5.330	+4.220	0.48	+4.088	0.610	1.511	0.441
E-13	4	16	0.006	0.006	0.8	135.0	0.002											
E-16	146	4	0.058	0.058	0.8	135.0	0.018	0.019		EP-5-2	9.10	+5.220	+3.463	0.10	+3.454	0.457	0.567	0.093
E-14	20	40	0.080	0.080	0.85	135.0	0.026											
E-15	70	40	0.280	0.280	0.05	135.0	0.005											
E-17	146	4	0.058	0.058	0.8	135.0	0.018											
E-18	75	30	0.225	0.225	0.8	135.0	0.068											
E-19	10	32	0.032	0.032	0.8	135.0	0.010	0.145		EP-5-1	15.30	+5.220	+3.310	0.10	+3.295	0.610	0.687	0.201
								0.705		EP-5	145.00	+5.190	+3.776	0.22	+3.461	0.914	1.326	0.869
E-20	5	170	0.043	0.043	0.8	135.0	0.013											
E-21			1.800	1.800	0.5	135.0	0.338	1.055		EP-6	58.00	+4.890	+3.171	0.10	+3.113	1.219	1.090	1.271

Prepared by	[signature]	Checked by	Y. Ando
	July / 18 /2002		19 / 07 /2002

FN: Calculation_Sheet

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Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Storm Drainage	Page No. 6	Rev.

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CALCULATIONS FOR STORMWATER DRAINAGE (Trench)

Dimension of Trench :

	150 x 150	300 x 300	360 x 360	450 x 450	600 x 600
A	0.0214	0.0624	0.0744	0.1440	0.2592
P	0.3800	0.7400	0.7900	1.1700	1.5000
R	0.0563	0.0843	0.0941	0.123	0.1728
$R^{2/3}$	0.1469	0.1923	0.2069	0.2473	0.3102

Roughness Coefficient	n	0.014

Required Discharging Water Volume

	Catchment Area (ha)				C	I	Q (m3/sec)		Remark
A									
A-2-1	10	35	0.035	0.035	0.5	135.0	0.007		
E-20	5	170	0.043	0.043	0.8	135.0	0.013	0.019	
A-4	5	40	0.018	0.018	0.8	135.0	0.005		
A-1	26	40	0.104	0.104	0.85	135.0	0.033	0.039	
A-7'	13	86	0.111	0.111	0.85	135.0	0.036		
A-8	5	86	0.043	0.043	0.8	135.0	0.013	0.048	
A-11'	13	87	0.114	0.114	0.85	135.0	0.036		
A-11''	5	87	0.044	0.044	0.8	135.0	0.013	0.049	
A-15'	13	94	0.122	0.122	0.85	135.0	0.039		
A-15''	5	94	0.047	0.047	0.8	135.0	0.014	0.053	
A-18'	75	120	0.450	0.450	0.5	135.0	0.084		
A-18''	5	120	0.060	0.060	0.8	135.0	0.018	0.102	
A-18'	40	45	0.090	0.090	0.8	135.0	0.027		
A-18''	13	45	0.059	0.059	0.8	135.0	0.018	0.045	
A-3	Trapezoid		0.188	0.188	0.5	135.0	0.035		
A-1'	65	40	0.260	0.260	0.85	135.0	0.083	0.118	
A-5	Trapezoid		0.276	0.276	0.7	135.0	0.072		
A-7	89	36	0.160	0.160	0.85	135.0	0.051	0.123	
A-9	89	58	0.258	0.258	0.7	135.0	0.068		
A-12	92	38	0.175	0.175	0.7	135.0	0.046	0.114	
A-17'	26	29	0.038	0.038	0.85	135.0	0.012	0.012	
A-14	92	54	0.248	0.248	0.7	135.0	0.065		
A-17''	26	70	0.091	0.091	0.85	135.0	0.029	0.094	
B									
B-1	101	12	0.061	0.061	0.5	135.0	0.011		
B-2	85	6	0.026	0.026	0.85	135.0	0.008		
B-3	121	17	0.103	0.103	0.85	135.0	0.033		
B-4'	70	36	0.252	0.252	0.85	135.0	0.080		
B-5	91	36	0.164	0.164	0.7	135.0	0.043	0.176	
B-12	89	53	0.236	0.236	0.7	135.0	0.062		
B-13	70	36	0.126	0.126	0.7	135.0	0.033	0.095	
B-19	74	58	0.215	0.215	0.7	135.0	0.056		
B-20	77	38	0.146	0.146	0.7	135.0	0.038	0.095	
B-26'	20	29	0.058	0.058	0.85	135.0	0.018	0.018	
B-25	77	54	0.208	0.208	0.7	135.0	0.055		
B-26'	66	29	0.191	0.191	0.85	135.0	0.061	0.115	
B-4'	70	36	0.252	0.252	0.85	135.0	0.080		

Pipe Culvert

Trench No.	Length (m)	Ground Level (m)	Slope of Road (%)	Min. Depth of Trench (m)	Ave. Depth of Trench (m)	Max. Depth of Trench (m)	Height of cover (m)	Level of bottom of trench	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max Q (m3/sec)
AU-1	75.00	+5.522	0.200	+0.300	+0.300	+0.300	+0.100	+5.122	+0.200	+4.972	0.300	1.942	0.121
AU-2	40.00	+5.522	0.200	+0.300	+0.300	+0.300	+0.100	+5.122	+0.200	+5.042	0.300	1.942	0.121
AU-3	85.75	+5.332	0.200	+0.300	+0.300	+0.300	+0.100	+4.932	+0.200	+4.761	0.300	1.942	0.121
AU-4	87.49	+5.132	0.200	+0.300	+0.300	+0.300	+0.100	+4.732	+0.200	+4.557	0.300	1.942	0.121
AU-5	93.60	+4.928	0.200	+0.300	+0.300	+0.300	+0.100	+4.528	+0.200	+4.341	0.300	1.942	0.121
AU-4-1	110.00	+5.148	0.200	+0.300	+0.300	+0.300	+0.100	+4.748	+0.200	+4.528	0.300	1.942	0.121
AU-5-1	50.00	+4.878	0.100	+0.300	+0.300	+0.300	+0.100	+4.478	+0.100	+4.428	0.300	1.373	0.086
AU-6	40.00	+5.332	0.000	+0.450	+0.470	+0.490	+0.100	+4.782	+0.100	+4.742	0.450	1.767	0.254
AU-7	36.00	+5.132	0.000	+0.450	+0.468	+0.486	+0.100	+4.582	+0.100	+4.546	0.450	1.767	0.254
AU-8	38.00	+4.928	0.000	+0.450	+0.469	+0.488	+0.100	+4.378	+0.100	+4.340	0.450	1.767	0.254
AU-9	26.00	+4.711	0.000	+0.300	+0.313	+0.326	+0.100	+4.311	+0.100	+4.285	0.300	1.373	0.086
AU-9-1	70.00	+4.711	0.000	+0.300	+0.370	+0.405	+0.100	+4.311	+0.150	+4.206	0.300	1.681	0.105
	751.84												
BU-1	66.00	+5.332	0.000	+0.450	+0.483	+0.516	+0.100	+4.782	+0.100	+4.716	0.450	1.767	0.254
BU-2	66.00	+5.132	0.000	+0.450	+0.483	+0.516	+0.100	+4.582	+0.100	+4.516	0.450	1.767	0.254
BU-3	66.00	+4.928	0.000	+0.450	+0.483	+0.516	+0.100	+4.378	+0.100	+4.312	0.450	1.767	0.254
BU-7	20.00	+4.711	0.000	+0.300	+0.310	+0.320	+0.100	+4.311	+0.100	+4.291	0.300	1.373	0.086
BU-7-1	66.00	+4.711	0.000	+0.450	+0.483	+0.516	+0.100	+4.161	+0.100	+4.095	0.450	1.767	0.254

Prepared by	[signature]	Checked by	Y. Ando
	July / 18 / 2002		19 / 07 / 2002

FN: Calculation_Sheet

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Storm Drainage	Page No. 7	Rev.

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	150 x 150	300 x 300	360 x 360	450 x 450	600 x 600
A	0.0214	0.0624	0.0744	0.1440	0.2592
P	0.3800	0.7400	0.7900	1.1700	1.5000
R	0.0563	0.0843	0.0941	0.123	0.1728
$R^{2/3}$	0.1469	0.1923	0.2069	0.2473	0.3102

Roughness Coefficient	n	0.014

Required Discharging Water Volume										Pipe Culvert													
Catchment Area (ha)					C	I	Q (m3/sec)		Remark	Trench No.	Length (m)	Ground Level (m)	Slope of Road (%)	Min. Depth of Trench (m)	Ave. Depth of Trench (m)	Max. Depth of Trench (m)	Height of cover (m)	Level of bottom of trench	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max. Qc (m3/sec)
B-6	89	36	0.160	0.160	0.7	135.0	0.042	0.122		BU-4	36.00	+5.332	0.000	+0.450	+0.468	+0.486	+0.100	+4.782	+0.100	+4.746	0.450	1.767	0.254
B-8	91	53	0.241	0.241	0.7	135.0	0.063																
B-9	77	38	0.146	0.146	0.7	135.0	0.038	0.102		BU-5	66.00	+5.132	0.000	+0.300	+0.366	+0.432	+0.100	+4.732	+0.200	+4.600	0.300	1.942	0.121
B-15	77	58	0.223	0.223	0.7	135.0	0.059																
B-16	81	38	0.154	0.154	0.7	135.0	0.040	0.099		BU-6-1	66.00	+4.928	0.000	+0.450	+0.483	+0.516	+0.100	+4.378	+0.100	+4.312	0.450	1.767	0.254
B-26'	6	29	0.017	0.017	0.85	135.0	0.006	0.006		BU-8	20.00	+4.711	0.000	+0.300	+0.310	+0.320	+0.100	+4.311	+0.100	+4.291	0.300	1.373	0.086
B-26'	6	29	0.017	0.017	0.85	135.0	0.006	0.006		BU-8-1	66.00	+4.711	0.000	+0.300	+0.410	+0.366	+0.100	+4.311	+0.100	+4.245	0.300	1.373	0.086
C											538.00												
C-1'	65	5	0.033	0.033	0.8	135.0	0.010	0.010		CU-1	65.00	+5.637	0.000	+0.300	+0.333	+0.365	+0.100	+5.237	+0.100	+5.172	0.300	1.373	0.086
C-2'	26	35	0.091	0.091	0.85	135.0	0.029	0.029		CU-2	26.00	+5.507	0.500	+0.300	+0.300	+0.300	+0.100	+5.107	+0.500	+4.977	0.300	3.070	0.192
C-5	70	49	0.172	0.172	0.75	135.0	0.048																
C-10	82	124	0.169	0.169	0.5	135.0	0.032	0.080		CU-3	85.75	+5.332	0.200	+0.300	+0.300	+0.300	+0.100	+4.932	+0.200	+4.761	0.300	1.942	0.121
C-12	13	87	0.114	0.114	0.85	135.0	0.036																
C-10	82	124	0.339	0.339	0.5	135.0	0.064	0.100		CU-4	87.49	+5.132	0.233	+0.300	+0.300	+0.300	+0.100	+4.732	+0.233	+4.529	0.300	2.093	0.131
C-11	141	78	0.550	0.550	0.5	135.0	0.103																
C-16	172	39	0.335	0.335	0.5	135.0	0.063	0.166		CU-5-1	105.00	+4.928	0.000	+0.450	+0.503	+0.555	+0.100	+4.378	+0.100	+4.273	0.450	1.767	0.254
C-18	52	94	0.243	0.243	0.5	135.0	0.046																
C-19	13	94	0.122	0.122	0.85	135.0	0.039	0.084		CU-5	93.60	+4.928	0.200	+0.300	+0.300	+0.300	+0.100	+4.528	+0.200	+4.341	0.300	1.942	0.121
C-5	70	49	0.172	0.172	0.75	135.0	0.024																
C-7	48	86	0.206	0.206	0.7	135.0	0.054	0.078		CU-6	85.75	+4.928	0.200	+0.300	+0.300	+0.300	+0.100	+4.528	+0.200	+4.357	0.300	1.942	0.121
C-12	25	94	0.235	0.235	0.85	135.0	0.037																
C-13	52	94	0.244	0.244	0.7	135.0	0.064	0.102		CU-7	87.49	+4.928	0.200	+0.300	+0.300	+0.300	+0.100	+4.528	+0.200	+4.353	0.300	1.942	0.121
C-19	25	91	0.227	0.227	0.85	135.0	0.036																
C-20	50	91	0.227	0.227	0.7	135.0	0.059	0.096		CU-8	93.60	+4.928	0.200	+0.300	+0.300	+0.300	+0.100	+4.528	+0.200	+4.341	0.300	1.942	0.121
C-17	182	54	0.491	0.491	0.5	135.0	0.092																
C-22'	104	29	0.301	0.301	0.85	135.0	0.096	0.188		CU-9-2	104.00	+4.711	0.000	+0.450	+0.502	+0.554	+0.100	+4.161	+0.100	+4.057	0.450	1.767	0.254
C-22'	26	29	0.075	0.075	0.85	135.0	0.024	0.024		CU-9-2	26.00	+4.711	0.000	+0.300	+0.313	+0.326	+0.100	+4.311	+0.100	+4.285	0.300	1.373	0.086
C-21	78	55	0.215	0.215	0.7	135.0	0.056																
C-22'	68	29	0.197	0.197	0.85	135.0	0.063	0.119		CU-9-1	68.00	+4.711	0.000	+0.450	+0.434	+0.518	+0.100	+4.161	+0.100	+4.093	0.450	1.767	0.254
D											927.68												
D2-7	10	152	0.152	0.152	0.8	135.0	0.046	0.046		DU-1	152.00	+6.050	0.500	+0.300	+0.300	+0.300	+0.100	+5.650	+0.500	+4.890	0.300	3.070	0.192
D2-5	20	60	0.060	0.060	0.85	135.0	0.019																
D2-6	10	30	0.030	0.030	0.85	135.0	0.010	0.029		DU-2	45.00	+5.300	0.250	+0.300	+0.300	+0.300	+0.100	+4.900	+0.250	+4.788	0.300	2.171	0.135
D2-1	160	13	0.208	0.208	0.8	135.0	0.062	0.062		DU-3	160.00	+5.140	0.000	+0.300	+0.380	+0.460	+0.100	+4.740	+0.100	+4.580	0.300	1.373	0.086
D2-4	60	35	0.210	0.210	0.8	135.0	0.063																
D2-3	75	12	0.090	0.090	0.8	135.0	0.027																
D2-2	160	13	0.208	0.208	0.8	135.0	0.062	0.152		DU-4	160.00	+5.140	0.000	+0.450	+0.530	+0.610	+0.100	+4.590	+0.100	+4.430	0.450	1.767	0.254
D1-2	9	90	0.082	0.082	0.8	135.0	0.025	0.025		DU-5	105.00	+5.140	0.200	+0.300	+0.300	+0.300	+0.100	+4.740	+0.200	+4.530	0.300	1.942	0.121
D1-1	9	90	0.082	0.082	0.8	135.0	0.025	0.025		DU-5-1	70.00	+5.140	0.200	+0.300	+0.300	+0.300	+0.100	+4.740	+0.200	+4.600	0.300	1.942	0.121
D-9'	5	89	0.041	0.041	0.8	135.0	0.012	0.012		DU-6	89.00	+4.970	0.200	+0.300	+0.300	+0.300	+0.100	+4.570	+0.200	+4.392	0.300	1.942	0.121

Prepared by	(signature)	Checked by	Y. Ando
	July / 18 / 2002		19 / 07 / 2002

FN: Calculation_Sheet

NIPPON KOEI CO.,LTD.

Project	Detailed Design on Port Reactivation Project in La Union	Calc. File No.	
Section	Civil	Calc. Index No.	
Subject	Storm Drainage	Page No. 8	Rev.

References/ Notes

2002/7/2514 0

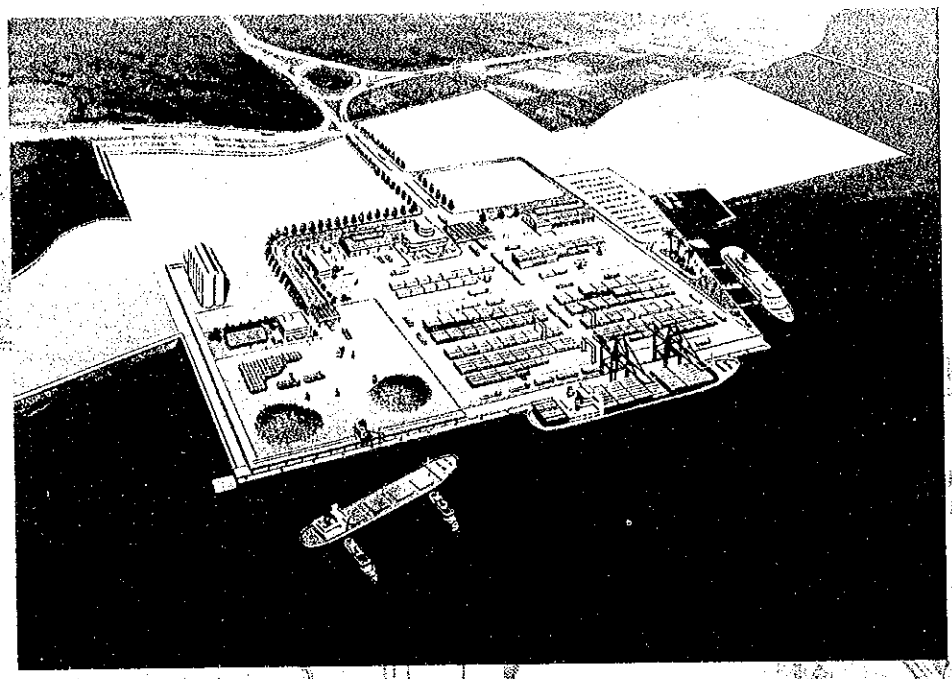
	150x150	300 x 300	360 x 360	450 x 450	600 x 600
A	0.0214	0.0624	0.0744	0.1440	0.2592
P	0.3800	0.7400	0.7900	1.1700	1.5000
R	0.0563	0.0843	0.0941	0.123	0.1728
$R^{2/3}$	0.1469	0.1923	0.2069	0.2473	0.3102

Roughness Coefficient	n	0.014

Required Discharging Water Volume										Pipe Culvert													
	Catchment Area (ha)				C	I	Q (m3/sec)		Remark	Trench No.	Length (m)	Ground Level (m)	Slope of Road (%)	Min. Depth of Trench (m)	Ave. Depth of Trench (m)	Max. Depth of Trench (m)	Height of cover (m)	Level of bottom of trench	Grade (%)	Elevation (Outlet)	Diameter (m)	v (m/sec)	Max Q (m3/sec)
D-9'	5	89	0.041	0.041	0.8	135.0	0.012	0.012		DU-6-1	89.00	+4.970	0.200	+0.300	+0.300	+0.300	+0.100	+4.570	+0.200	+4.392	0.300	1.942	0.121
D-3	268	50	0.670	0.670	0.05	135.0	0.013																
D-1	360	370	13.320	13.320	0.05	135.0	0.250	0.262		DU-7	355.00	+4.625	0.000	+0.450	+0.716	+0.983	+0.100	+4.075	+0.150	+3.543	0.450	2.164	0.312
D-4	39	90	0.176	0.176	0.05	135.0	0.003	0.003		DU-8	90.00	+5.164	0.500	+0.300	+0.300	+0.300	+0.100	+4.764	+0.500	+4.314	0.300	3.070	0.192
D-5	268	40	0.536	0.536	0.05	135.0	0.010																
D-6	258	40	0.516	0.516	0.05	135.0	0.010	0.020		DU-9-1	150.00	+5.119	0.000	+0.300	+0.375	+0.450	+0.100	+4.719	+0.100	+4.569	0.300	1.373	0.086
D-11	50	90	0.225	0.225	0.05	135.0	0.004	0.004		DU-9	90.00	+5.164	0.100	+0.300	+0.300	+0.300	+0.100	+4.764	+0.100	+4.674	0.300	1.373	0.086
D-10	258	50	0.645	0.645	0.05	135.0	0.012																
D-12	234	55	0.644	0.644	0.05	135.0	0.012	0.024		DU-10-1	150.00	+5.119	0.000	+0.300	+0.375	+0.450	+0.100	+4.719	+0.100	+4.569	0.300	1.373	0.086
D-13	131	72	0.470	0.470	0.5	135.0	0.088	0.088		DU-10	127.50	+5.019	0.170	+0.300	+0.300	+0.300	+0.100	+4.619	+0.170	+4.402	0.300	1.790	0.112
C-4	50	50	0.250	0.250	0.5	135.0	0.047	0.047		DU-10-2	50.00	+5.010	0.000	+0.300	+0.343	+0.385	+0.100	+4.810	+0.170	+4.725	0.300	1.790	0.112
D-14	192	78	0.749	0.749	0.5	135.0	0.140																
D-15	166	39	0.324	0.324	0.5	135.0	0.061	0.201		DU-11-1	110.00	+4.844	0.000	+0.450	+0.505	+0.560	+0.100	+4.294	+0.100	+4.184	0.450	1.767	0.254
D-16	57	91	0.258	0.258	0.5	135.0	0.048	0.048		DU-11	93.60	+4.844	0.150	+0.300	+0.300	+0.300	+0.100	+4.444	+0.150	+4.304	0.300	1.681	0.105
D-17	166	54	0.448	0.448	0.5	135.0	0.084																
D-18	112	29	0.324	0.324	0.85	135.0	0.103	0.187		DU-11-2	110.00	+4.711	0.000	+0.450	+0.402	+0.560	+0.100	+4.161	+0.100	+4.051	0.450	1.767	0.254
E											2196.10												
E-4	175	4	0.070	0.070	0.8	135.0	0.021																
E-1			5.015	5.015	0.05	135.0	0.094	0.115		EU-1	178.00	+6.050	0.000	+0.300	+0.478	+0.656	+0.100	+5.650	+0.200	+5.294	0.300	1.942	0.121
E-5'	5	17	0.008	0.008	0.8	135.0	0.002	0.002		EU-2	22.00	+6.060	0.466	+0.300	+0.300	+0.300	+0.100	+5.660	+0.466	+5.557	0.300	2.964	0.185
E-10	4	95	0.038	0.038	0.8	135.0	0.011	0.011		EU-3	81.47	+5.970	0.466	+0.300	+0.300	+0.300	+0.100	+5.570	+0.466	+5.190	0.300	2.964	0.185
E-2	95	460	4.370	4.370	0.05	135.0	0.082	0.082		EU-4-1	90.00	+5.590	0.000	+0.300	+0.368	+0.435	+0.100	+5.190	+0.150	+5.055	0.300	1.681	0.105
E-11	4	55	0.022	0.022	0.8	135.0	0.007	0.007		EU-4	55.00	+5.590	0.466	+0.300	+0.300	+0.300	+0.100	+5.190	+0.466	+4.934	0.300	2.964	0.185
E-12	4	16	0.006	0.006	0.8	135.0	0.002	0.002		EU-5	27.30	+5.330	0.466	+0.300	+0.300	+0.300	+0.100	+4.930	+0.466	+4.803	0.300	2.964	0.185
E-5	175	4	0.070	0.070	0.8	135.0	0.021	0.021		EU-6	185.00	+5.940	0.000	+0.300	+0.393	+0.485	+0.100	+5.540	+0.100	+5.355	0.300	1.373	0.086
E-9	4	150	0.060	0.060	0.8	135.0	0.018	0.018		EU-7	165.33	+5.970	0.466	+0.300	+0.300	+0.300	+0.100	+5.570	+0.466	+4.800	0.300	2.964	0.185
E-6	8	170	0.136	0.136	0.85	135.0	0.043	0.043		EU-8	142.69	+5.940	0.500	+0.300	+0.300	+0.300	+0.100	+5.540	+0.500	+4.827	0.300	3.070	0.192
E-16	146	4	0.058	0.058	0.8	135.0	0.018	0.018		EU-9	175.00	+5.230	0.000	+0.300	+0.431	+0.563	+0.100	+4.830	+0.150	+4.568	0.300	1.681	0.105
E-13	4	16	0.006	0.006	0.8	135.0	0.002	0.002		EU-9-1	22.00	+5.340	0.000	+0.300	+0.351	+0.403	+0.100	+4.940	+0.466	+4.837	0.300	2.964	0.185
E-7	165	150	2.475	2.475	0.05	135.0	0.046																
E-8	165	17	0.281	0.281	0.05	135.0	0.005	0.052		EU-10	165.33	+4.675	0.000	+0.300	+0.383	+0.465	+0.100	+4.275	+0.100	+4.110	0.300	1.373	0.086
E-15	70	40	0.280	0.280	0.05	135.0	0.005																
E-16	146	4	0.058	0.058	0.8	135.0	0.018	0.023		EU-9-1	140.00	+5.230	0.000	+0.300	+0.370	+0.440	+0.100	+4.830	+0.100	+4.690	0.300	1.373	0.086
E-20	5	170	0.043	0.043	0.8	135.0	0.013	0.013		EU-11	145.00	+5.220	0.200	+0.300	+0.300	+0.300	+0.100	+4.820	+0.200	+4.530	0.300	1.942	0.121
E-21			1.800	1.800	0.5	135.0	0.338	0.373		EU-12	54.00	+4.890	0.000	+0.450	+0.385	+0.585	+0.100	+4.340	+0.250	+4.205	0.450	2.794	0.402

	Prepared by	Checked by
	Gaelo (signature)	Y. Ando (signature)
	July / 18 /2002	19 / 07 /2002

FN: Calculation_Sheet



JICA