Appendix A-7

Structural Calculations for Water Treatment Plant

CONTENTS

1. GENERAL

1. ОБЩЕЕ ОПИСАНИЕ

1. GENERAL

1.1 Reference Standards

BS 8110 : Structural use of Concrete
BS 8007 : Code of Practice for Design of Concrete Structures for Retaining Aqueous Liquids
BS CP3 : Code of Basic Data for Design of Buildings: Chapter V: Part 2: Loading Uniform Building By-laws, 1984

1.2 Design Materials

This calculation is based on the following design materials.

· Concrete	BS 8110	Grade 30 or Equivalent :	fcu=30 N/mm^2
	BS 8007	Grade 30A or Equivalent :	fcu=30 N/mm^2
· Reinforcing Bar	BS 4449	High Yield Deformed Bar Grade 365 or Equivalent:	fy=365 N/mm^2

(fy: high yield having a minimum characteristic strength)

1.3 Design Ground Level and Ground Water Level

Design Ground Water Level (GWL)
GWL =

1.4 Minimum Concrete Cover

Minimum concrete cover on the outer reinforcement shall be as follows.

- Cast against and permanently exposed to earth	75mm
- Exposed to earth, weather or water	50mm
- Not exposed to weather or contact with the ground: slabs, walls, beams, girders, columns	40mm

1.5 Crack width control

Crack width control shall satisfy the requirements of the BS 8007:1987.

1) Allowable crack width:	0.2 mm (Section3.2.2 of BS 8007)
2) Applicable Structure:	Pit and Basin

1.6 Design Loadings

1) DEAD LOADS : (DL)

Unit Weight of Materials

Water	: 10 kN/m^3
Soil	: 18 kN/m^3
Plain concrete	: 23 kN/m^3
Reinforced concrete	: 24 kN/m^3

2) LIVE LOADS (Imposed Loads) : (LL)

3) EARTH PRESSURE / WATER PRESSURE : (EP/WP)

1.7 LOAD COMBINATIONS

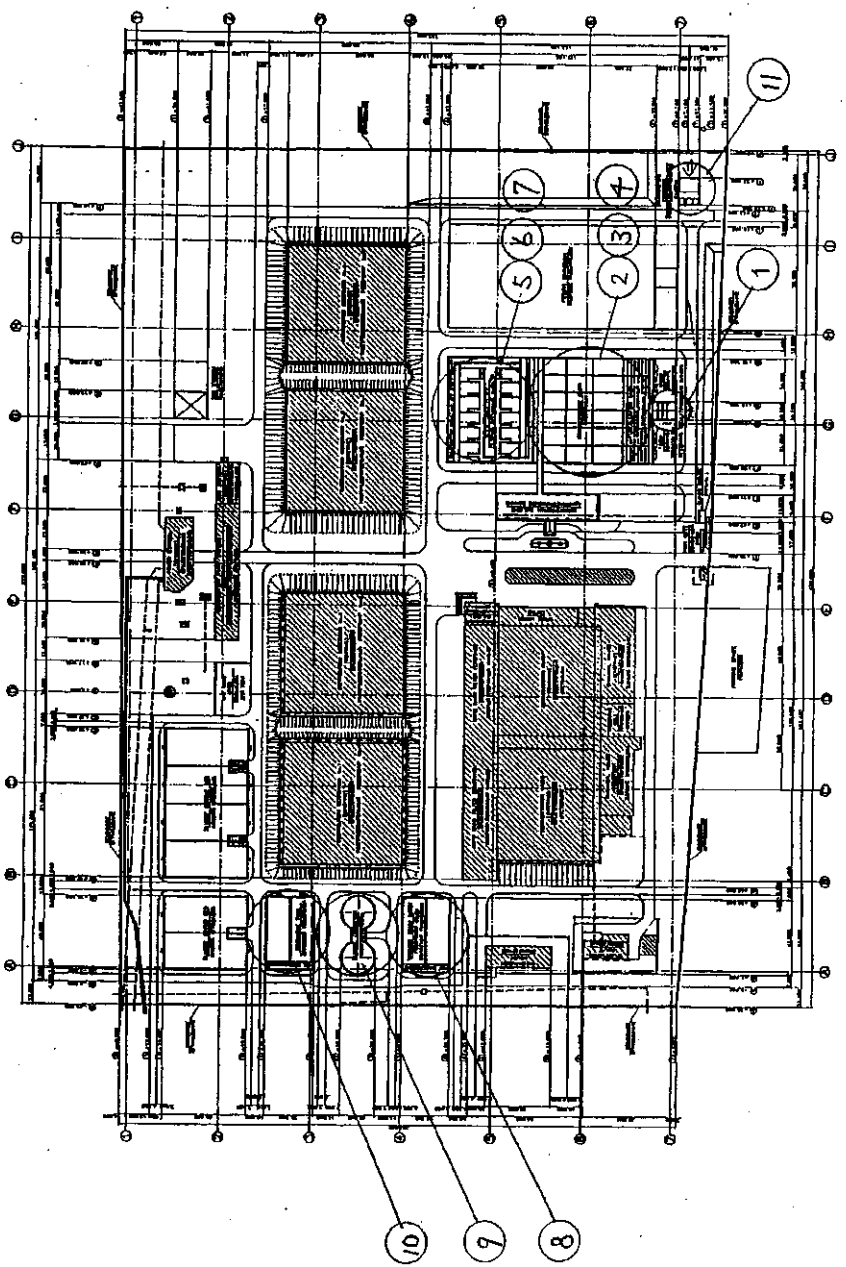
1) Load combinations and Load factors for Pit/Basin based on BS 5950, BS 8110 and UBC are applied.

Pit & Basin

1.4 (DL) + 1.6 (LL) + 1.4 (EP)

1.4 (DL) + 1.6 (LL) + 1.4 (EP + WP)

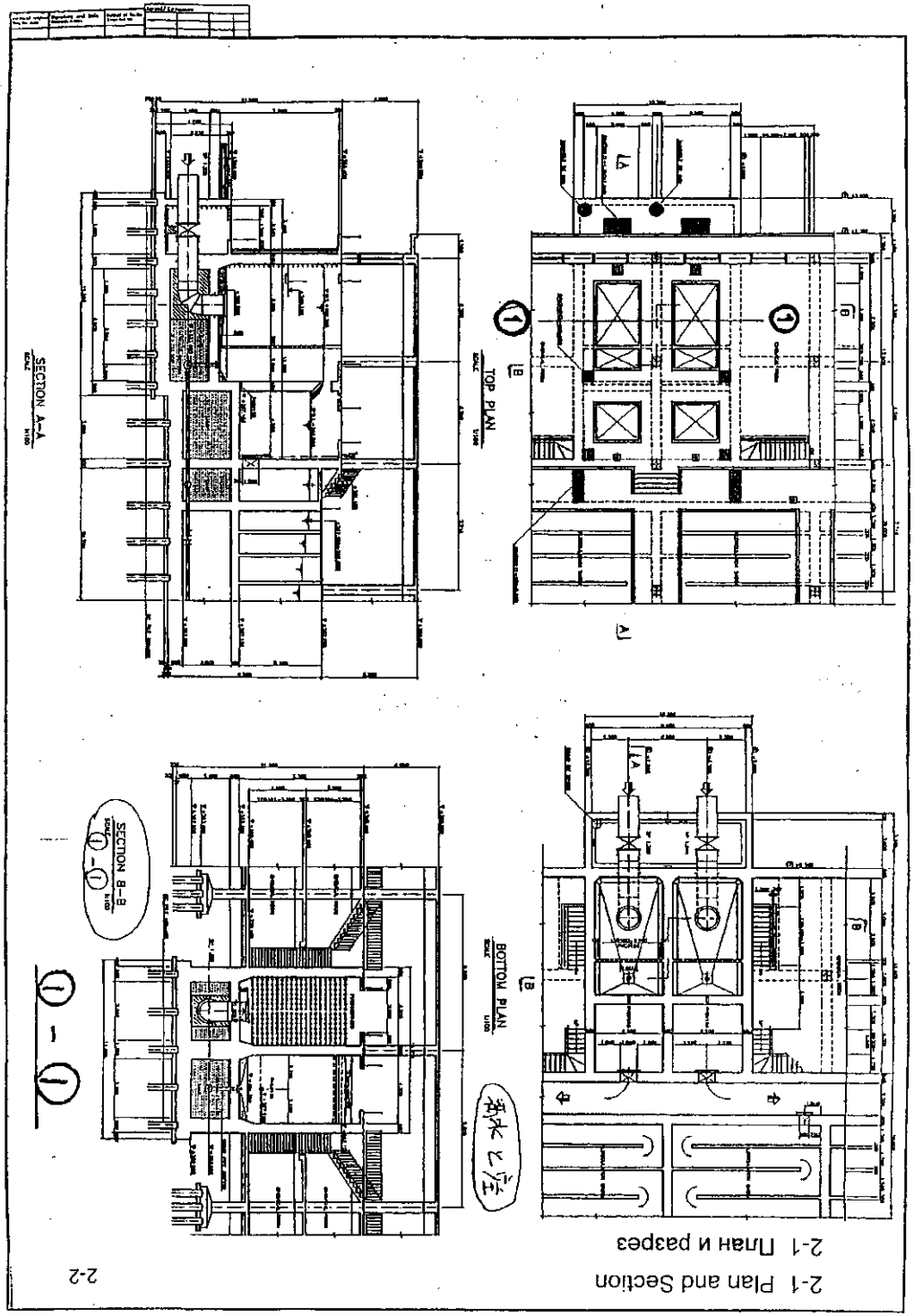
Remarks : The stability of the structure shall be checked for non-factored load combinations.



GENERAL LAYOUT
ГЕНЕРАЛЬНЫЙ ПЛАН

2. RECEIVING WELL

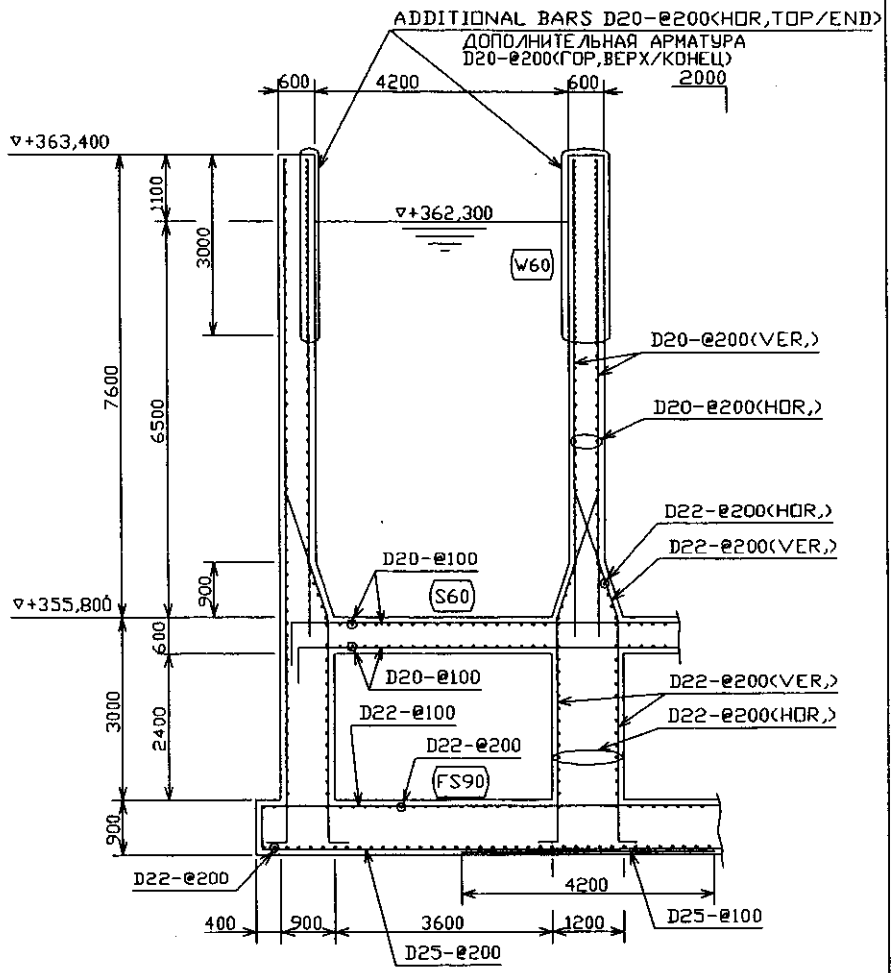
2. ПРИЕМНАЯ КАМЕРА



2-1 Plan and Section

2-1 План и разрез

2.2 DESIGN OF WALL & SLAB ① – ①
2.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ПЛИТЫ

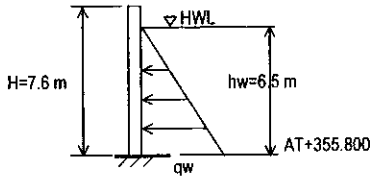


① – ①
S=1/80

A.7-5

2.2.1 CALCULATION OF WALL (W60) ①-①
(AT+355.800)

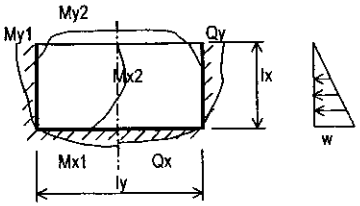
1) DESIGN LOAD (Water Pressure)



hw = 6.50 m
γw = 10.0 KN/m3

qw = γw · hw = 65.0 KN/m2/m

2) FACTORED STRESS (W60)



lx = 6.50 m
ly = 7.20 m
λ = 1.11
w=qw = 65.0 KN/m2/m
Factored Load
w'=1.4 · w = 91.00 KN/m2/m

w' · lx^2 = 3844.8
w' · lx = 591.5

SEE Fig.2

Mx1 = 0.040 x 3844.8 = 153.8 (KN · m/m)
Mx2 = 0.010 x 3844.8 = 38.4
My1 = 0.033 x 3844.8 = 126.9
My2 = 0.012 x 3844.8 = 46.1

Qx = 0.35 x 591.5 = 207.0 (KN/m)
Qy = 0.25 x 591.5 = 147.9

3) DESIGN OF SECTION

a) VERTICAL : BOT (AT+355.800)

Mu = 153.8 KN·m
Vu = 207.0 KN/m

b = 1000 mm fy = 365 N/mm2
D = 900 mm fcu = 30 N/mm2
d = 840 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.007 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 833
Z2 = 0.95 · d = 798
Z = 798
As 1 = Mu /0.95·fy · Z = 556 mm2
Asmin = 0.0013 · b · D = 1170 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.25 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.23 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.41 N/mm2 > V = 0.25 N/mm2 OK

b) HORIZONTAL : TOP/END

Mu = 126.9 KN·m
Vu = 147.9 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.016 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 511
Z2 = 0.95 · d = 494
Z = 494
As 1 = Mu /0.95·fy · Z = 741 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.28 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.37 < 3.0
400/d = 0.8 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.48 N/mm2 > V = 0.28 N/mm2 OK

4) CHECK OF CRACKING ①-①
W60 (VERTICAL:BOT.)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 900 mm
dv = 840 mm
dh = 820 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ· b· d1 = 875 mm2
As (her.) = ρ· b· d1 = 875 mm2

USE ; VERTICAL D 22 @ 200 (As = 1900 mm2)
USE ; HORIZONTAL D 22 @ 200 (As = 1900 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Ver. Mu = 153.8 KN·m M = 109.9 KN·m b = 1000 mm
Hor. Mu = KN·m M = 0.0 KN·m D = 900 mm
dv = 840 mm
dh = 820 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu·b·dv^2) = 0.0052
Z1 = dv · [0.5 + √(0.25−K/0.9)] = 835
Z2 = 0.95·dv = 798
Z = 798
As = M / fy · Z = 1059.4 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

HORIZONTAL

K = M / (fcu·b·dh^2) = 0
Z1 = dh · [0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95·dh = 0
Z = 0
As = M / fy · Z = 0 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)·(φ/2ρ(V)) = 969.74 mm
Smax(H) = (fct/fb)·(φ/2ρ(H)) = 969.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b·d1 = 0.0076
ρ(H) = As/b·d1 = 0.0076

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)·(α/2)·T1 = 0.19 < 0.2 mm
Wmax(H)= Smax(H)·(α/2)·T1 = 0.19 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 40 from TABLE 4.2

W60 (HORIZONTAL:END) ①-①

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = KN・m M = 0.0 KN・m b = 1000 mm
Hor. Mu = 126.9 KN・m M = 90.6 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dv = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0.0112
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 513
Z2 = 0.95・dh = 494
Z = 494
As = M / fy・Z = 1410.8 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fcl/fb)・(φ/2ρ(V)) = 1063.5 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1063.5 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.19 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.19 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 35 from TABLE 4.2

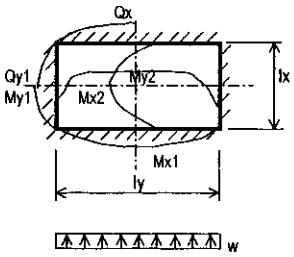
A 7-7

2.2.2 CALCULATION OF SLAB (S60) ①-①

(AT+355.800)

1) DESIGN LOAD & FACTORED STRESS

hw = 6.50 m
t = 0.60 m
γw = 10.0 KN/m3
γc = 24.0 KN/m4
w=γw・hw+γc・t = 79.4 KN/m2/m



lx = 3.60 m
ly = 6.90 m
λ = 1.92

w = 79.4 KN/m2/m
w'=1.4・w = 111.16 KN/m2/m

w'・lx^2 = 1440.6
w'・lx = 400.2

SEE Fig.2

Mx1 = 0.083 x 1440.6 = 119.6 (KN・m/m)
Mx2 = 0.040 x 1440.6 = 57.6
My1 = 0.057 x 1440.6 = 82.1
My2 = 0.010 x 1440.6 = 14.4

Qx = 0.52 x 400.2 = 208.1 (KN/m)
Qy = 0.46 x 400.2 = 184.1

2) DESIGN OF SECTION

Mu = 119.6 KN・m
Vu = 208.1 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.014 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 532
Z2 = 0.95・d = 513
Z = 513
As 1 = Mu /0.95・fy・Z = 672 mm2
Asmin = 0.0013・b・D = 780 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.39 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.29 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.45 N/mm2 > V = 0.39 N/mm2 OK

3) CHECK OF CRACKING ①-①
SLAB (S60)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 600 mm d(B) = 100 mm
d = 540 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ · b · d(T) = 875 mm2
As (bot) = ρ · b · d(B) = 350 mm2

USE ;	TOP	D 20	@ 200	(As = 1570 mm2)
USE ;	BOTTOM	D 20	@ 200	(As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top Mu = 119.6 KN·m M = 85.4 KN·m b = 1000 mm
Bott. Mu = 82.1 KN·m M = 58.6 KN·m D = 600 mm
d = 540 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.0098
Z1 = d · [0.5 + √(0.25 − K/0.9)] = 534
Z2 = 0.95·d = 513
Z = 513
As = M / fy · Z = 1280.6 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.0067
Z1 = d · [0.5 + √(0.25 − K/0.9)] = 536
Z2 = 0.95·d = 513
Z = 513
As = M / fy · Z = 878.69 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 1063.5 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 426.8 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0063
ρ(B) = As/b·d(B) = 0.0157

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)·(α/2)·T1 = 0.13 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.05 < 0.2 mm

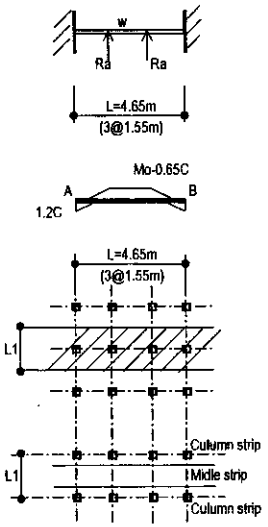
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

A.7-8

2.2.3 CALCULATION OF FOOTING SLAB (FS90) ①-①
(AT+352.800)

1) DESIGN LOAD & FACTORED STRESS



· Design load
Sand : Ds = 2.4 m
w1 =17.0 · Ds · L1 = 68.1 KN/m
F.Slab : Df = 0.9 m
w2 =24.0 · D · L1 = 36.1 KN/m
· Factored Load w' = 1.4 · (w1+w2) = 145.9 KN/m
· Pile Reaction Ra = 525 KN/pile
Ra' = 1.4 · Ra = 735 KN/pile

· Factored stress
L = 4.65 m
C=(2/9 · Ra' · L)-(1/12 · w' · L^2) = 496.6 KN · m
Mo=(1/3 · Ra' · L)-(1/8 · w' · L^2) = 744.9 KN · m

M_A = 1.3 · C = 645.6 KN · m
Mo-0.65C = 422.1 KN · m
Vu = Ra' - 1/2 · w' · L = 395.8 KN

· Culumn strip
L1 = 1.67 m
BOT: Mu1=0.375 · (1.3 · C)/(1/4 · L1) = 579.9 KN · m
TOP: Mu2=0.375 · (Mo-0.65 · C)/(1/4 · L1) = 379.2 KN · m

2) DESIGN OF SECTION ①-① Revised all sheet

a) HORIZONTAL : BOT/END

Mu = 579.9 KN·m
Vu = 395.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 900 mm fcu = 30 N/mm2
d = 840 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.027 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 814
Z2 = 0.95 · d = 798
Z = 798
As 1 = Mu /0.95· fy · Z = 2096 mm2
Asmin = 0.0013 · b · D = 1170 mm2

USE ; D 25 @ 100 (As = 4910 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.47 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.58 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.56 N/mm2 > V = 0.47 N/mm2 OK

b) HORIZONTAL : TOP/CENT

Mu = 379.2 KN·m
Vu = 395.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 900 mm fcu = 30 N/mm2
d = 820 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.019 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 803
Z2 = 0.95 · d = 779
Z = 779
As 1 = Mu /0.95· fy · Z = 1404 mm2
Asmin = 0.0013 · b · D = 1170 mm2

USE ; D 22 @ 100 (As = 3800 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.48 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.46 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.52 N/mm2 > V = 0.48 N/mm2 OK

3) CHECK OF CRACKING ①-①
FOOTING SLAB (FS90)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 900 mm d(B) = 100 mm
d = 740 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ· b· d(T) = 875 mm2
As (bot) = ρ· b· d(B) = 350 mm2

USE ; TOP D 22 @ 100 (As = 3800 mm2)
USE ; BOTTOM D 25 @ 100 (As = 4910 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top Mu = 379.2 KN·m M = 270.9 KN·m b = 1000 mm
Bott. Mu = 579.9 KN·m M = 414.2 KN·m D = 900 mm
d = 840 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.0128
Z1 = d · [0.5 + √(0.25−K/0.9)] = 828
Z2 = 0.95·d = 798
Z = 798
As = M / fy · Z = 2611.3 mm2

USE ; D 22 @ 100 (As = 3800 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.0196
Z1 = d · [0.5 + √(0.25−K/0.9)] = 821
Z2 = 0.95·d = 798
Z = 798
As = M / fy · Z = 3992.7 mm2

USE ; D 25 @ 100 (As = 4910 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 484.87 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 170.6 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0152
ρ(B) = As/b·d(B) = 0.0491

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

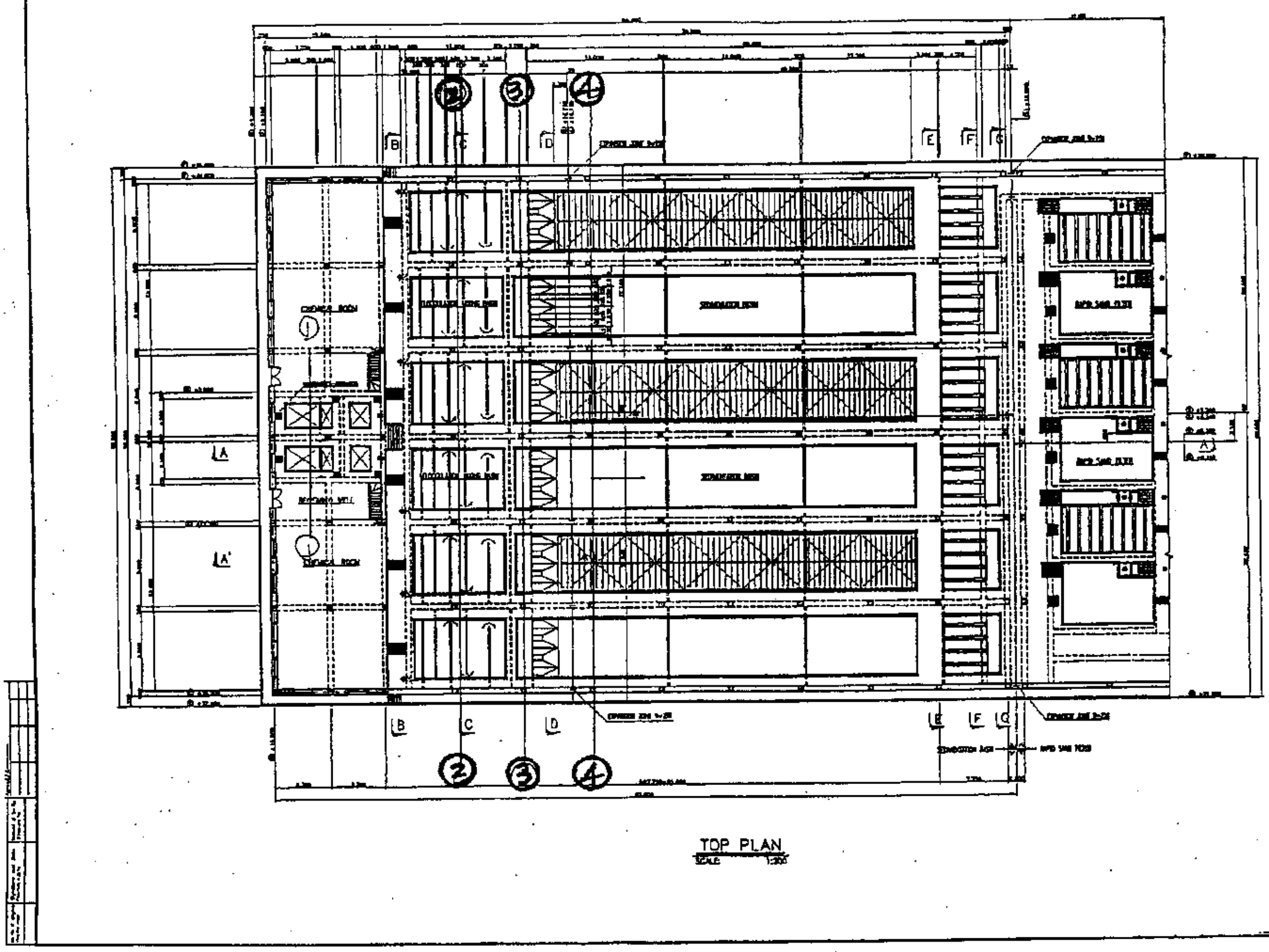
Wmax(T)= Smax(T)·(α/2)·T1 = 0.06 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.02 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

3-1 Plan and Section

3-1 План и разрез

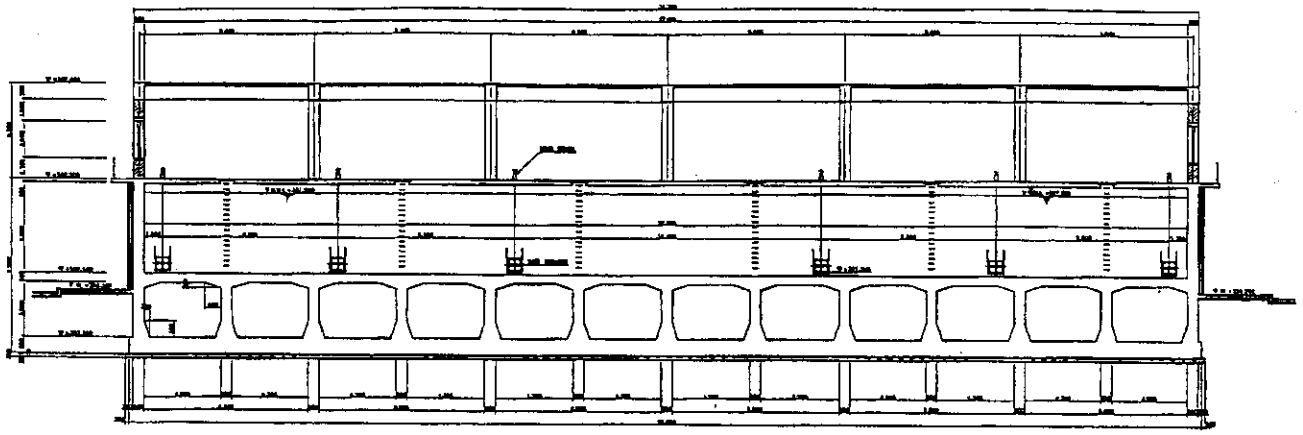


3-2

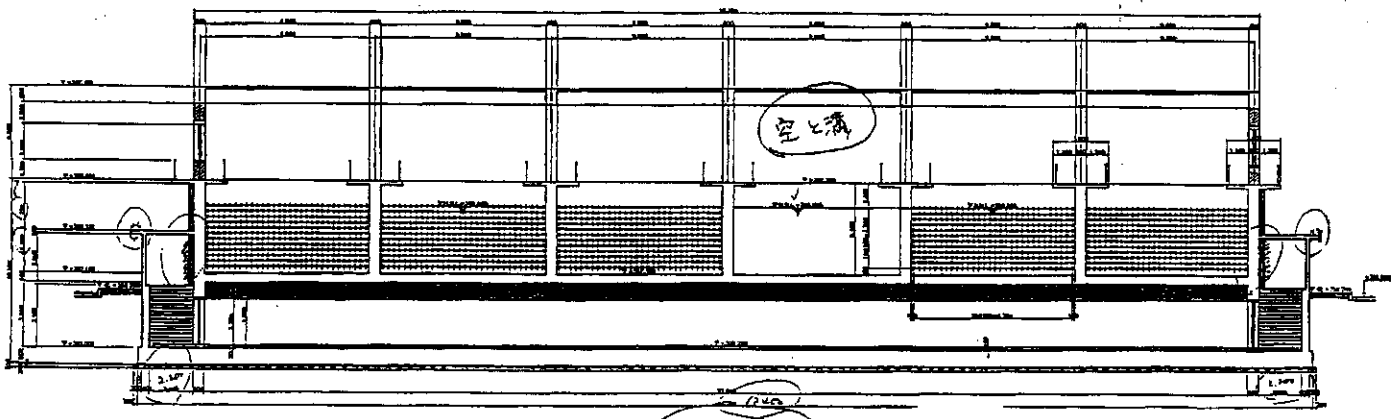
3-1

3. SEDIMENTATION BASIN

3. ОТСТОЙНИК



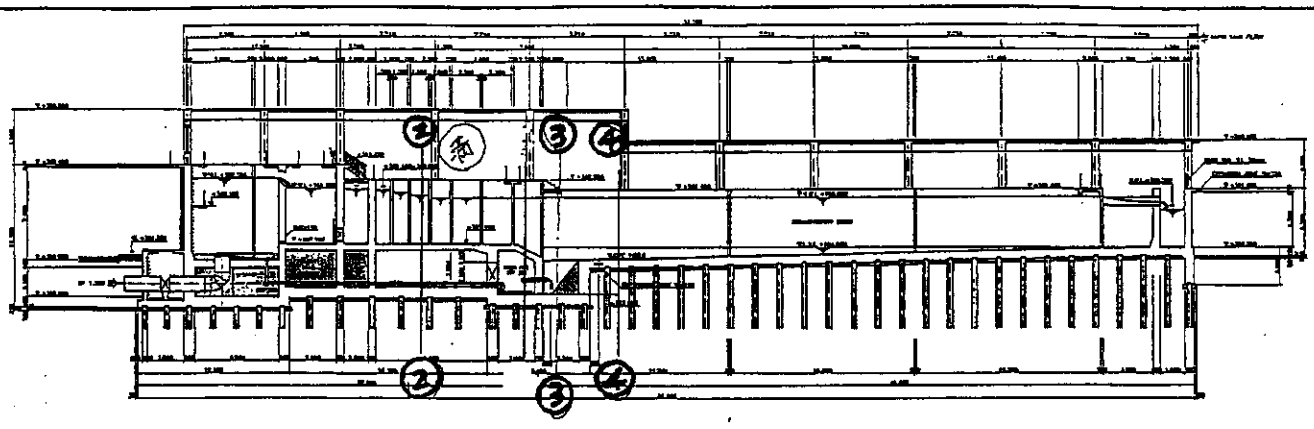
SECTION B–B



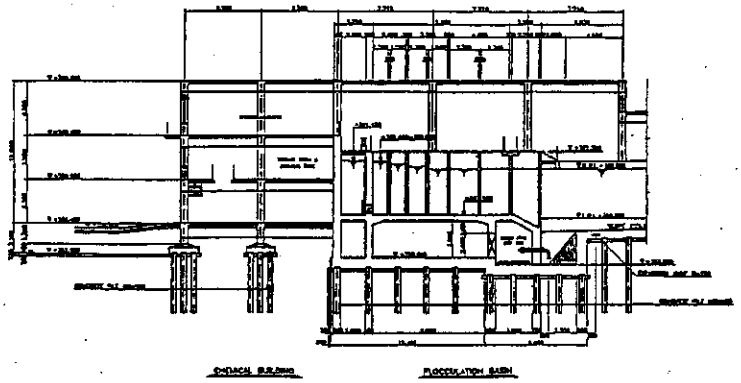
SECTION C–C

② -②

3-4

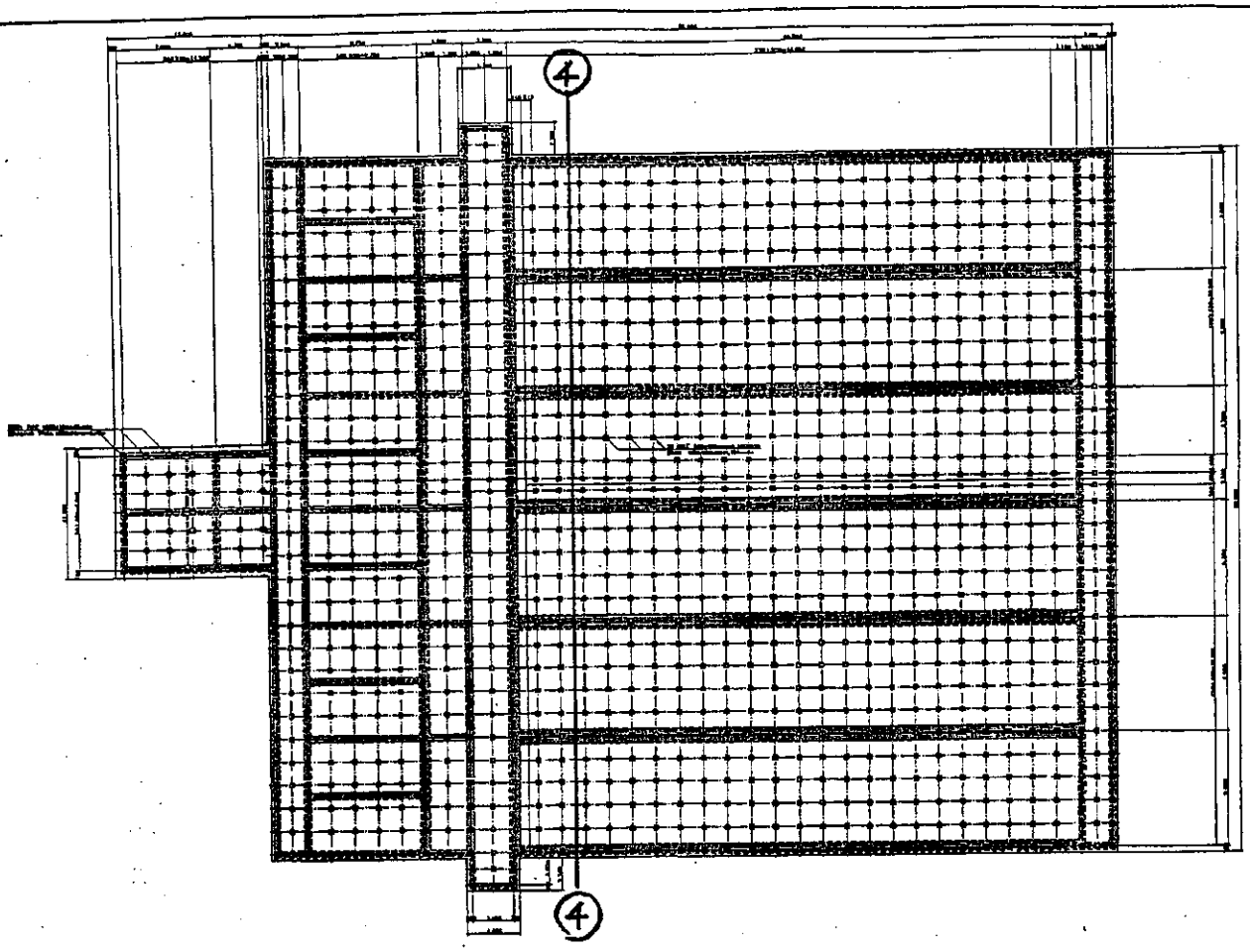


SECTION A–A



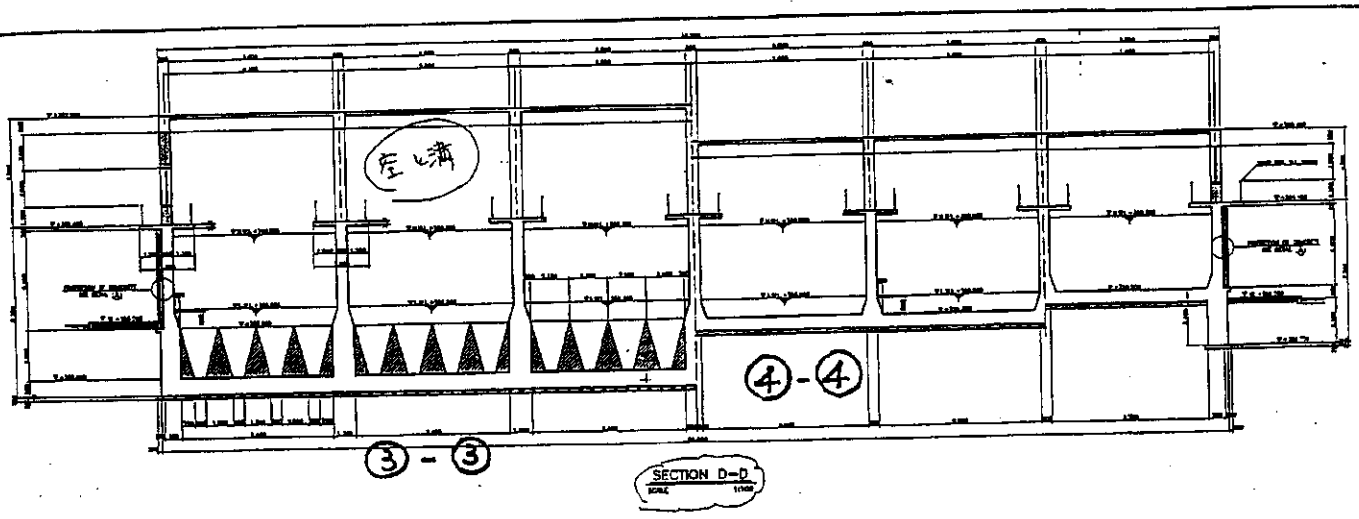
SECTION A'–A'

3-3

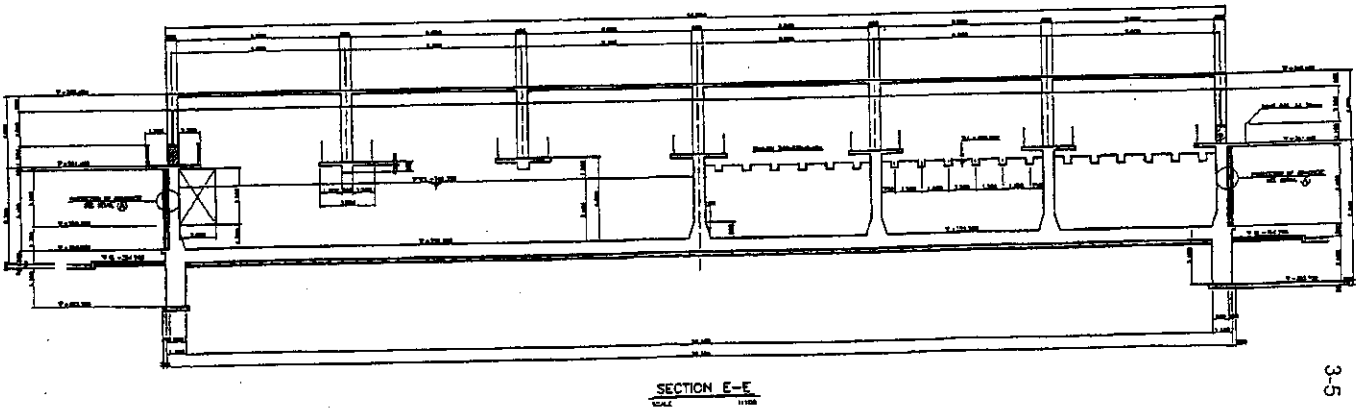


PILE ARRANGEMENT
РАССТАНОВКА СВАЙ

3-6



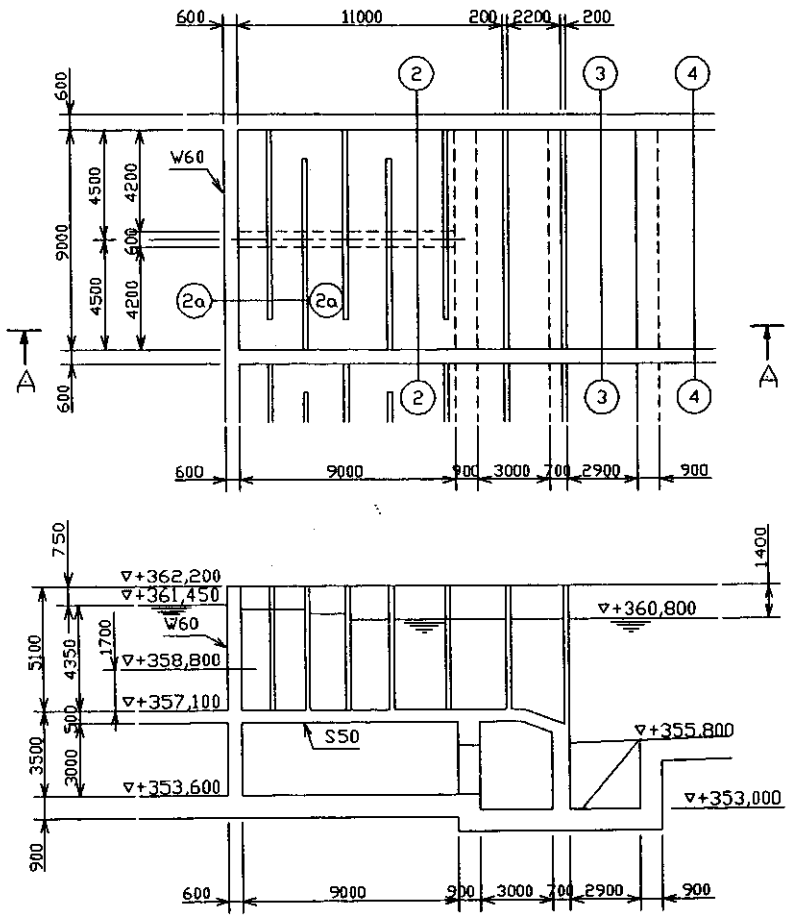
SECTION D-D



SECTION E-E

3-5

3.2 DESIGN OF WALL & SLAB ② – ②
3.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ПЛИТЫ



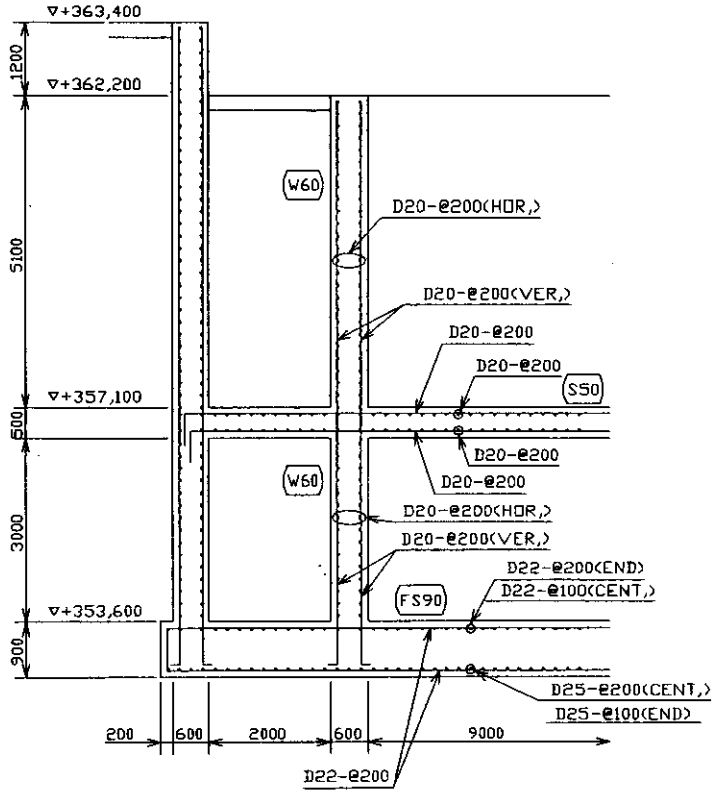
SECTION A-A/РАЗРЕЗ A-A

S=1/200

③ – ③ SAME AS ④ – ④

③ – ③ ТАК ЖЕ КАК ④ – ④

A.7-13



②a – ②a

CALCULATION OF FS90 SAME AS ① – ① SECTION REFER TO PAGE 2-3

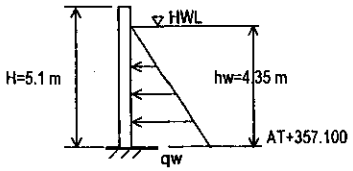
РАСЧЕТ FS90 ТАК ЖЕ, КАК РАЗРЕЗ ① – ① СМ. СТР. 2-3

S=1/80

3.2.1 CALCULATION OF WALL (W60) ②-②

(AT+357.100)

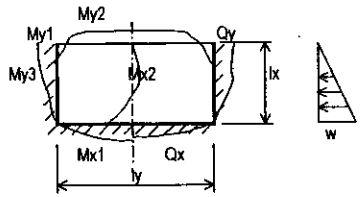
1) DESIGN LOAD (Water Pressure)



hw = 4.35 m
γw = 10.0 KN/m3

qw = γw · hw = 43.5 KN/m2/m

2) FACTORED STRESS (W60)



lx = 4.35 m
ly = 9.00 m
λ = 2.07
w=qw = 43.5 KN/m2/m

Factored Load
w'=1.4 · w = 60.90 KN/m2/m

w' · lx^2 = 1152.4
w' · lx = 264.9

SEE Fig.1

Mx1 =	0.088 x	1152.4 =	101.4	(KN · m/m)
Mx2 =	0.010 x	1152.4 =	11.5	
My1 =	0.068 x	1152.4 =	78.4	
My2 =	0.027 x	1152.4 =	31.1	
My3 =	0.068 x	1152.4 =	78.4	
Qx =	0.47 x	264.9 =	124.5	(KN/m)
Qy =	0.26 x	264.9 =	68.9	

3) DESIGN OF SECTION

a) VERTICAL : BOT (AT+357.100)

Mu = 101.4 KN·m
Vu = 124.5 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.012 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 533
Z2 = 0.95 · d = 513
Z = 513
As 1 = Mu /0.95·fy · Z = 570 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.23 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.29 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.45 N/mm2 > V = 0.23 N/mm2 OK

b) HORIZONTAL : TOP/END

Mu = 78.4 KN·m
Vu = 68.9 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.010 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 514
Z2 = 0.95 · d = 494
Z = 494
As 1 = Mu /0.95·fy · Z = 457 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.13 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.30 < 3.0
400/d = 0.8 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.45 N/mm2 > V = 0.13 N/mm2 OK

3) CHECK OF CRACKING ②-②
W60 (VERTICAL:BOT.)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Ver. Mu = 101.4 KN・m M = 72.4 KN・m b = 1000 mm
Hor. Mu = 78.4 KN・m M = 56.0 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.0083
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 535
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 1085.6 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0.0069
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 516
Z2 = 0.95・dh = 494
Z = 494
As = M / fy・Z = 872 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2p(V)) = 1063.5 mm
Smax(H) = (fct/fb)・(φ/2p(H)) = 1063.5 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

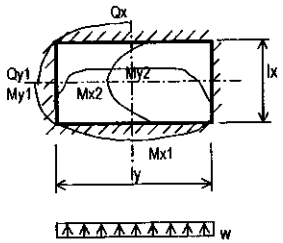
Wmax(V)= Smax(V)・(α/2)・T1 = 0.19 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.19 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 35 from TABLE 4.2

3.2.3 CALCULATION OF SLAB (S50) ②-②
(AT+357.100)

1) DESIGN LOAD & FACTORED STRESS



hw = 4.35 m
t = 0.50 m
γw = 10.0 KN/m3
γc = 24.0 KN/m4
w=γw・hw+γc・t = 55.5 KN/m2/m

lx = 4.20 m
ly = 9.00 m
λ = 2.14

w = 55.5 KN/m2/m
w'=1.4・w = 77.70 KN/m2/m

w'・lx^2 = 1370.6
w'・lx = 326.3

SEE Fig.2

Mx1 = 0.083 x 1370.6 = 113.8 (KN・m/m)
Mx2 = 0.041 x 1370.6 = 56.2
My1 = 0.057 x 1370.6 = 78.1
My2 = 0.010 x 1370.6 = 13.7

Qx = 0.52 x 326.3 = 169.7 (KN/m)
Qy = 0.46 x 326.3 = 150.1

2) DESIGN OF SECTION

Mu = 113.8 KN・m
Vu = 169.7 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]
K = Mu / (fcu・b・d^2) = 0.020 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 430
Z2 = 0.95・d = 418
Z = 418
As 1 = Mu /0.95・fy・Z = 785 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.39 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.36 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・[(100・As)/(b・d)]^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.48 N/mm2 > V = 0.39 N/mm2 OK

3) CHECK OF CRACKING ②-② SLAB (S50)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 500 mm d(B) = 100 mm
d = 440 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ· b· d(T) = 875 mm2
As (bot) = ρ· b· d(B) = 350 mm2

USE ; TOP D 20 @200 (As = 1570 mm2)
USE ; BOTTOM D 20 @200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Top Mu = 113.8 KN·m M = 81.3 KN·m b = 1000 mm
Bott. Mu = 78.1 KN·m M = 55.8 KN·m D = 500 mm
d = 440 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.014
Z1 = d · [0.5 + √ (0.25 − K/0.9)] = 433
Z2 = 0.95·d = 418
Z = 418
As = M / fy · Z = 1496.1 mm2

USE ; D 20 @200 (As = 1570 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.0096
Z1 = d · [0.5 + √ (0.25 − K/0.9)] = 435
Z2 = 0.95·d = 418
Z = 418
As = M / fy · Z = 1026.9 mm2

USE ; D 20 @200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 1063.5 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 426.8 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0063
ρ(B) = As/b·d(B) = 0.0157

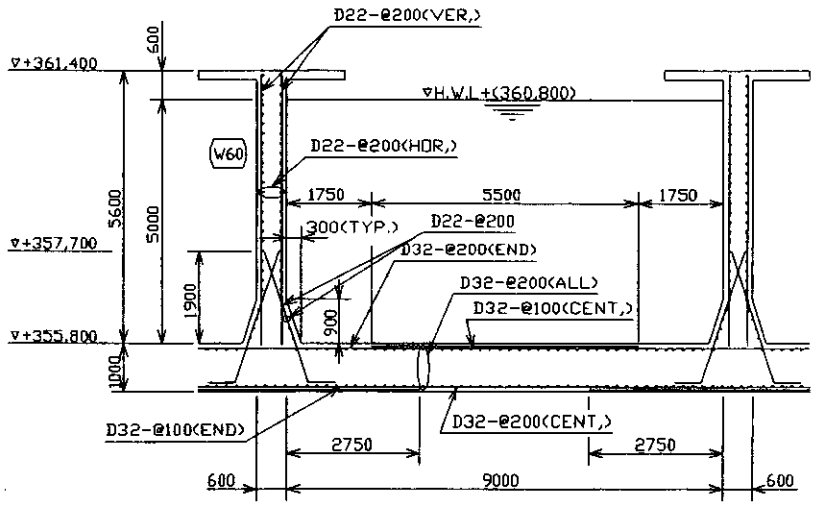
2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)·(α/2)·T1 = 0.13 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.05 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

3.3 DESIGN OF WALL & SLAB ④ − ④
3.3 ПРОЕКТИРОВАНИЕ СТЕНЫ И ПЛИТЫ

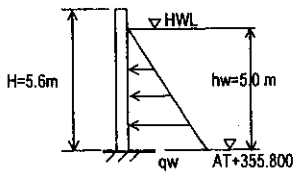


④ − ④
S=1/100

3.3.1 CALCULATION OF WALL (W60) ④-④

(AT+355.800)

1) DESIGN LOAD & FACTORED STRESS



H= 5.6 m
hw= 5.00 m
γw= 10.0 KN/m3

· Design load
qw =γw · hw = 10.0 x 5.00 = 50.0 (KN/m2/m)

· Factored Load
w' =1.4 · qw = 1.4 x 50.0 = 70.00 (KN/m2/m)

Mu = 1/6 · w' · hw^2 = 291.7 (KN · m/m)

Vu = 1/2 · w' · hw = 175.0 (KN/m)

2) DESIGN OF SECTION

Mu = 291.7 KN · m
Vu = 175.0 KN/m

b = 1000 mm fy = 365 N/mm2
D = 1200 mm fcu = 30 N/mm2
d = 1140 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.007 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 1130
Z2 = 0.95 · d = 1083
Z = 1083
As 1 = Mu /0.95 · fy · Z = 777 mm2
Asmin = 0.0013 · b · D = 1560 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.15 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.17 < 3.0
400/d = 0.4 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.37 N/mm2 > V = 0.15 N/mm2 OK

3) CHECK OF CRACKING ④-④

W60 (VERTICAL:BOT.)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 1200 mm
dv = 1140 mm
dh = 1120 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ · b · d1 = 875 mm2
As (her.) = ρ · b · d1 = 875 mm2

USE ; VERTICAL D 22 @ 200 (As = 1900 mm2)
USE ; HORIZONTAL D 22 @ 200 (As = 1900 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 291.7 KN · m M = 208.4 KN · m
Hor. Mu = 0.0 KN · m M = 0.0 KN · m

b = 1000 mm
D = 1200 mm
dv = 1140 mm
dh = 1120 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu · b · dv^2) = 0.0053
Z1 = dv · [0.5 + √(0.25−K/0.9)] = 1133
Z2 = 0.95 · dv = 1083
Z = 1083
As = M / fy · Z = 1480.2 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

HORIZONTAL

K = M / (fcu · b · dh^2) = 0
Z1 = dh · [0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95 · dh = 0
Z = 0
As = M / fy · Z = 0 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb) · (φ/2ρ(V)) = 969.74 mm
Smax(H) = (fct/fb) · (φ/2ρ(H)) = 969.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b · d1 = 0.0076
ρ(H) = As/b · d1 = 0.0076

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V) · (α/2) · T1 = 0.20 < 0.2 mm
Wmax(H)= Smax(H) · (α/2) · T1 = 0.20 < 0.2 mm

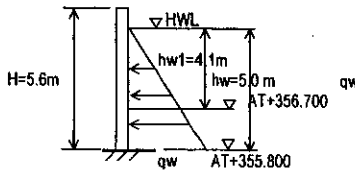
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 42 from TABLE 4.2

3.3.2 CALCULATION OF WALL (W60) ④-④

(AT+356.700)

1) DESIGN LOAD & FACTORED STRESS



H= 5.6 m
hw1= 4.1 m
γw1= 10.0 KN/m3

・Design load
qw1 =γw1 ・ hw1 = 10.0 x 4.10 = 41.0 (KN/m2/m)

・Factored Load
w1 =1.4・qw1 = 1.4 x 41.0 = 57.40 (KN/m2/m)

Mu = 1/6・w1・hw1^2 = 160.8 (KN・m/m)

Vu = 1/2・w1・hw1 = 117.7 (KN/m)

2) DESIGN OF SECTION

Mu = 160.8 KN・m
Vu = 117.7 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu ・ b ・ d^2) = 0.018 < 0.156
Z1 = d ・ [0.5 + √(0.25−K/0.9)] = 529
Z2 = 0.95 ・ d = 513
Z = 513
As 1 = Mu /0.95・fy ・ Z = 904 mm2
Asmin = 0.0013 ・ b ・ D = 780 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b ・ d) = 0.22 < 4.4 N/mm2 OK
(100 ・ As)/(b ・ d) = 0.35 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79 ・ {(100 ・ As)/(b ・ d)}^1/3 ・ (400/d)^1/4 ・ (1/1.25) ・ (fcu/25)^1/3
= 0.47 N/mm2 > V = 0.22 N/mm2 OK

3) CHECK OF CRACKING ④-④

W60 (VERTICAL:TOP)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・ b・ d1 = 875 mm2
As (her.) = ρ・ b・ d1 = 875 mm2

USE ; VERTICAL D 22 @ 200 (As = 1900 mm2)
USE ; HORIZONTAL D 22 @ 200 (As = 1900 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 160.8 KN・m M = 114.9 KN・m
Hor. Mu = 0.0 KN・m M = 0.0 KN・m

b = 1000 mm
D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0131
Z1 = dv ・ [0.5 + √(0.25−K/0.9)] = 532
Z2 = 0.95・dv = 513
Z = 513
As = M / fy ・ Z = 1722.9 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh ・ [0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy ・ Z = 0 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 969.74 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 969.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0076
ρ(H) = As/b・d1 = 0.0076

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

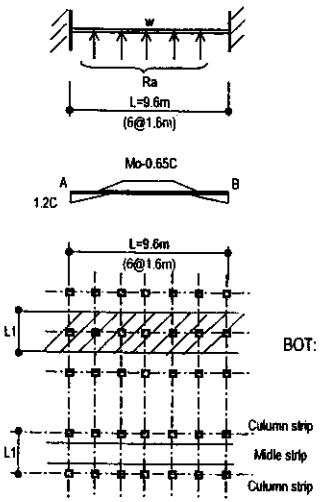
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 35 from TABLE 4.2

3.3.3 CALCULATION OF FOOTING SLAB (FS100) ④-④

(AT+355.800)

1) DESIGN LOAD & FACTORED STRESS



- Design load

	D	=	1.0 m
	w =24.0 · D · L1	=	41.5 KN/m
· Factored Load	w' = 1.4 · w	=	58.1 KN/m
· Pile Reaction	Ra	=	275 KN/pile
	Ra' = 1.4 · Ra	=	385 KN/pile

- Factored stress

	L	=	9.6 m
	C=(2/5 · Ra' · L)-(1/12 · w' · L^2)	=	1032.0 KN · m
	Mo=(3/5 · Ra' · L)-(1/8 · w' · L^2)	=	1548.0 KN · m
	M_A = 1.2 · C	=	1238.4 KN · m
	Mo-0.65C	=	877.2 KN · m
	Vu =(4/2 · Ra') -(1/2 · w' · L)	=	491.0 KN

- Column strip

	L1	=	1.73 m
	Mu1=0.375 · (1.2 · C)/(1/4 · L1)	=	1073.8 KN · m
	TOP: Mu2=0.375 · (Mo-0.65 · C)/(1/4 · L1)	=	760.5 KN · m

2) DESIGN OF SECTION

a) HORIZONTAL : BOT/END

Mu = 1073.8 KN·m
Vu = 491.0 KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 940 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2)	=	0.041 < 0.156
Z1 = d · [0.5 + √(0.25—K/0.9)]	=	896
Z2 = 0.95 · d	=	893
Z =		893
As 1 = Mu /0.95·fy · Z	=	3468 mm2
Asmin = 0.0013 · b · D	=	1300 mm2

USE ; D 32 @ 100 (As = 8040 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d)	=	0.52	<	4.4 N/mm2	OK
(100 · As)/(b · d)	=	0.86	<	3.0	
400/d	=	0.4	<	1.0 →	1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.64 N/mm2 > V = 0.52 N/mm2 OK

b) HORIZONTAL ; TOP/CENT

Mu = 760.5 KN·m
Vu = KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2)	=	0.094 < 0.156
Z1 = d · [0.5 + √(0.25—K/0.9)]	=	459
Z2 = 0.95 · d	=	494
Z =		459
As 1 = Mu /0.95·fy · Z	=	4783 mm2
Asmin = 0.0013 · b · D	=	780 mm2

USE ; D 32 @ 100 (As = 8040 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d)	=	0.00	<	4.4 N/mm2	OK
(100 · As)/(b · d)	=	1.55	<	3.0	
400/d	=	0.8	<	1.0 →	1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.78 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING ④-④
FOOTING SLAB (FS)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION	b =	1000	mm	SURFACE ZONE :	d(T) =	250	mm
	D =	1000	mm		d(B) =	100	mm
	d =	840	mm				

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ · b · d(T) = 875 mm2
As (bot) = ρ · b · d(B) = 350 mm2

USE ; TOP D 32 @ 100 (As = 8040 mm2)
USE ; BOTTOM D 32 @ 100 (As = 8040 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top	Mu =	760.6	KN·m	M =	543.3	KN·m	b = 1000 mm
Bott.	Mu =	1073.7	KN·m	M =	766.9	KN·m	D = 1000 mm
							d = 840 mm
							fy = 130 N/mm2
							fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2)	=	0.0257	
Z1 = d · [0.5 + √(0.25 − K/0.9)]	=	815	
Z2 = 0.95·d	=	798	
Z =		798	
As = M / fy · Z	=	5237.1	mm2

USE ; D 32 @ 100 (As = 8040 mm2)

BOTTOM

K = M / (fcu·b·d^2)	=	0.0362	
Z1 = d · [0.5 + √(0.25 − K/0.9)]	=	805	
Z2 = 0.95·d	=	798	
Z =		798	
As = M / fy · Z	=	7392.5	mm2

USE ; D 32 @ 100 (As = 8040 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T))	=	332.92	mm	
Smax(B) = (fct/fb)·(φ/2ρ(B))	=	133.3	mm	
Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) =		0.0322		
ρ(B) = As/b·d(B) =		0.0804		

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)·(α/2)·T1	=	0.04	<	0.2	mm
Wmax(B)= Smax(B)·(α/2)·T1	=	0.02	<	0.2	mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

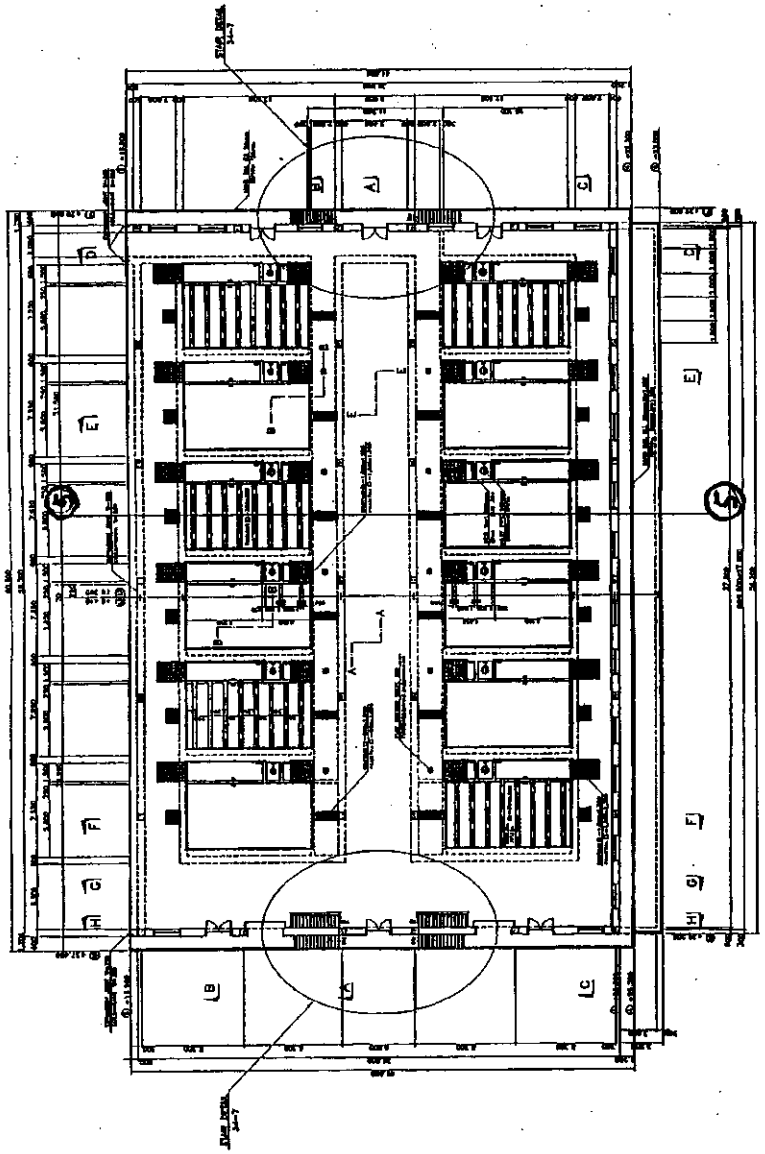
4. RAPID SAND FILTER

4. СКОРЫЙ ПЕСЧАНЫЙ ФИЛЬТР

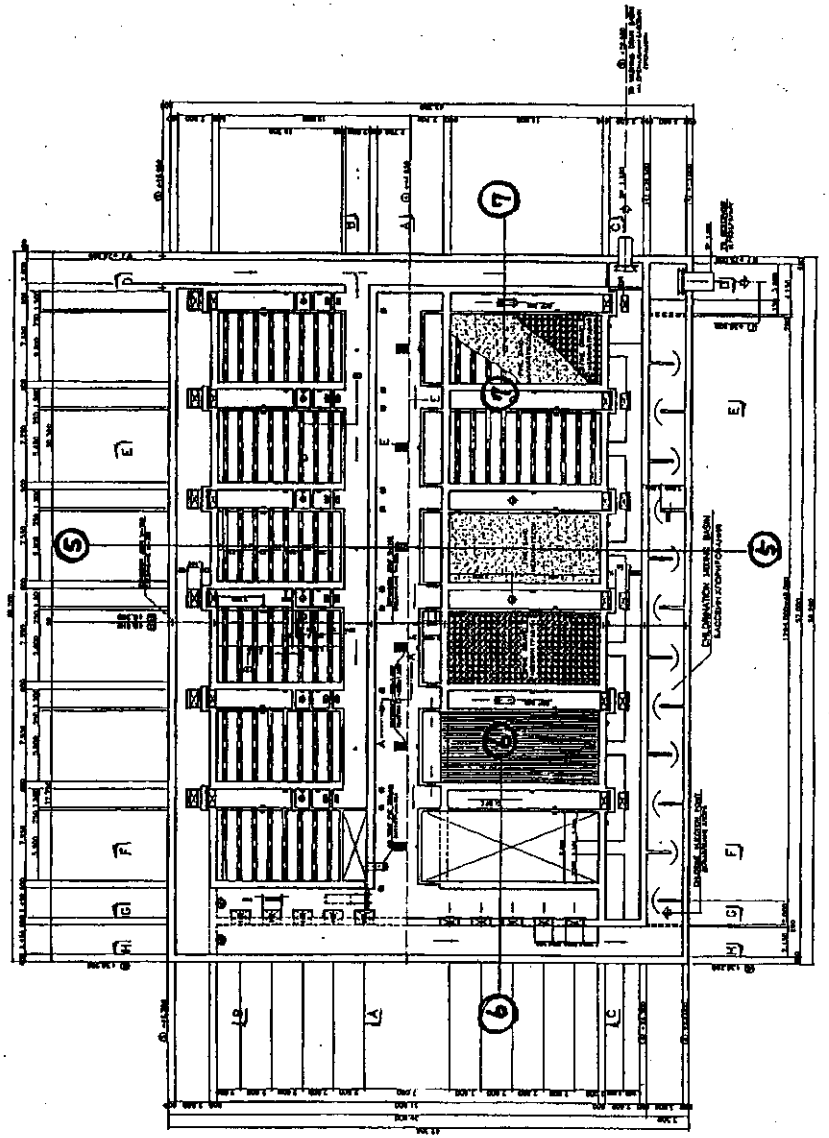
Sections 6 and 7 are the same as Section 5
Разделы 6 и 7 являются такими же, как и Раздел 5

4-1 Plan and Section

4-1 План и разрез

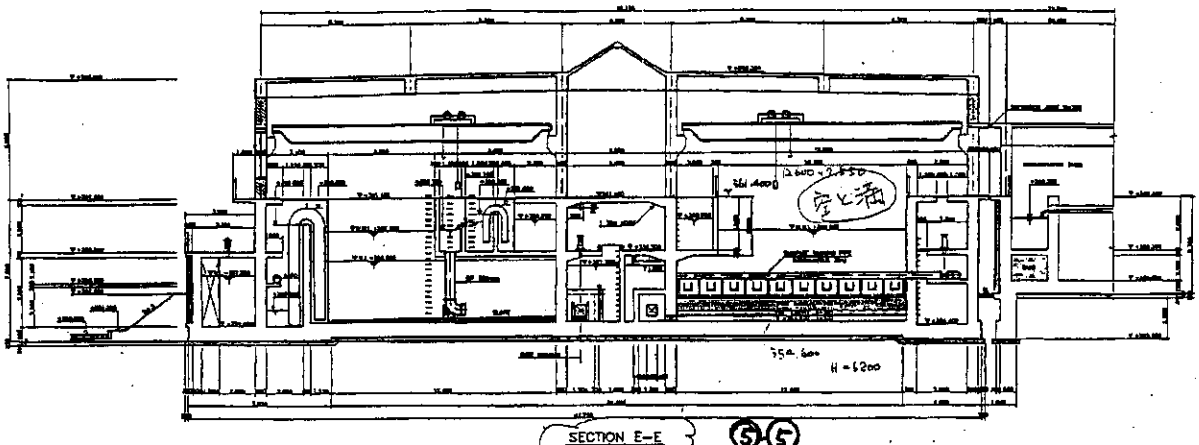


TOP PLAN
ПЛАН НАДЗЕМНОЙ ЧАСТИ

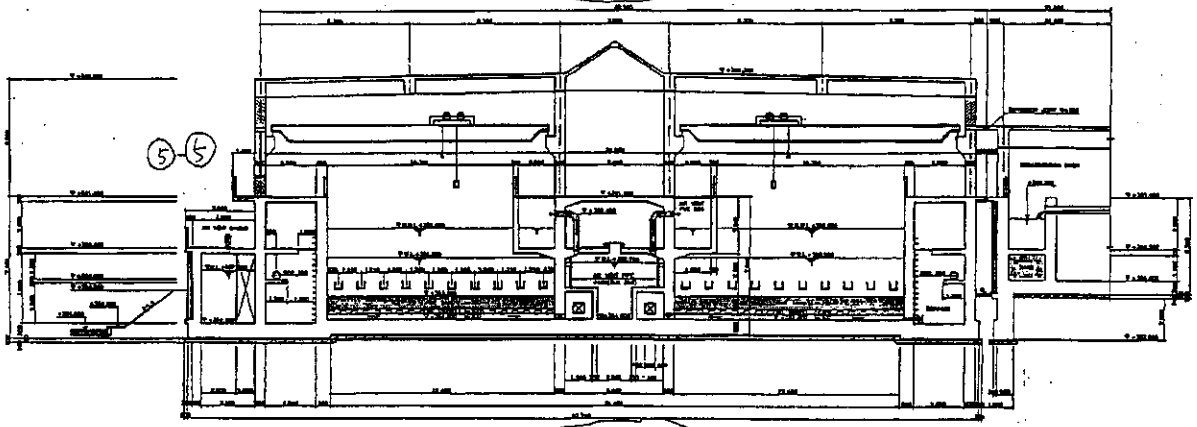


BOTTOM PLAN
ПЛАН ПОДЗЕМНОЙ ЧАСТИ

A.7-21

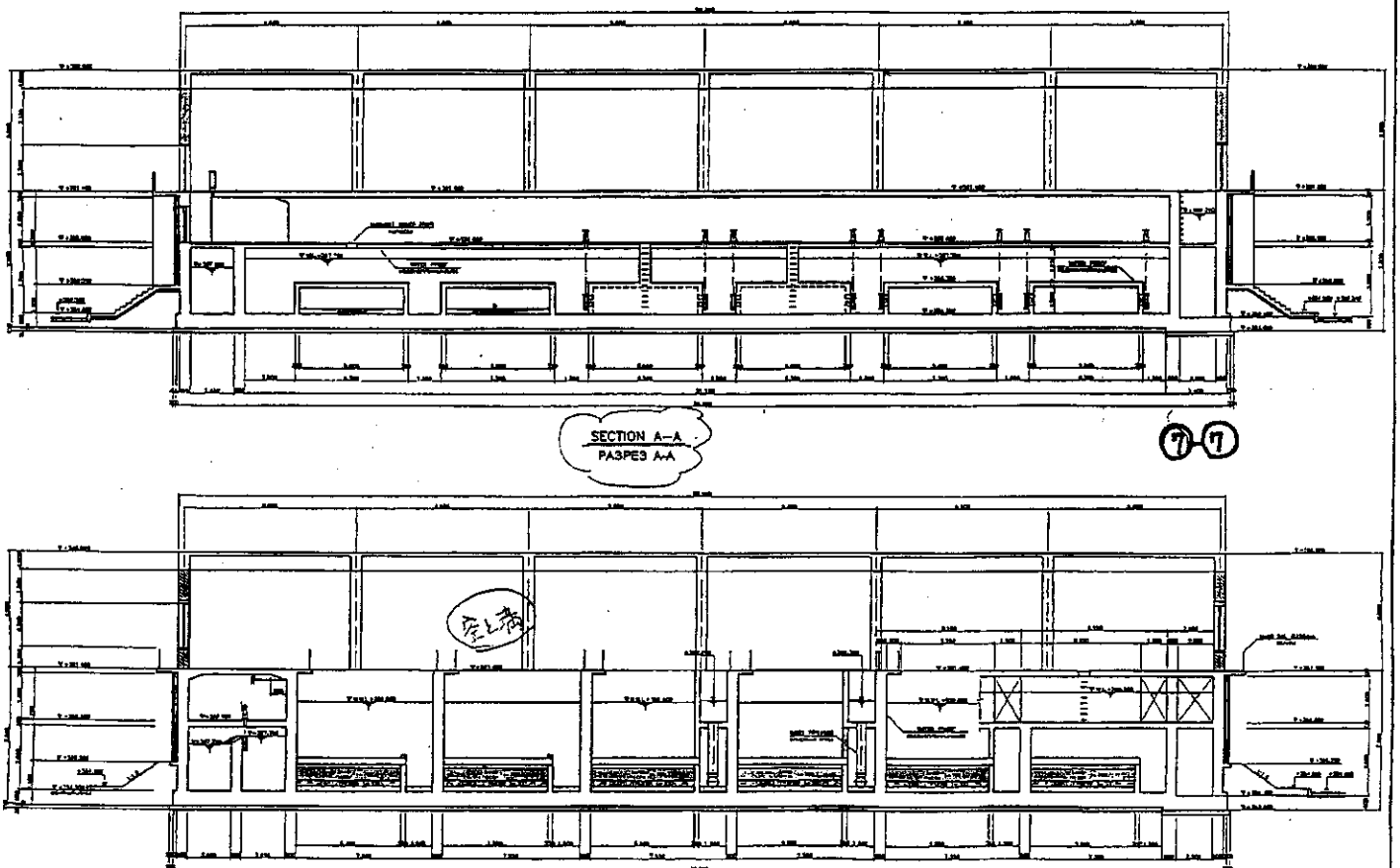


SECTION E–E



SECTION F–F

4-4

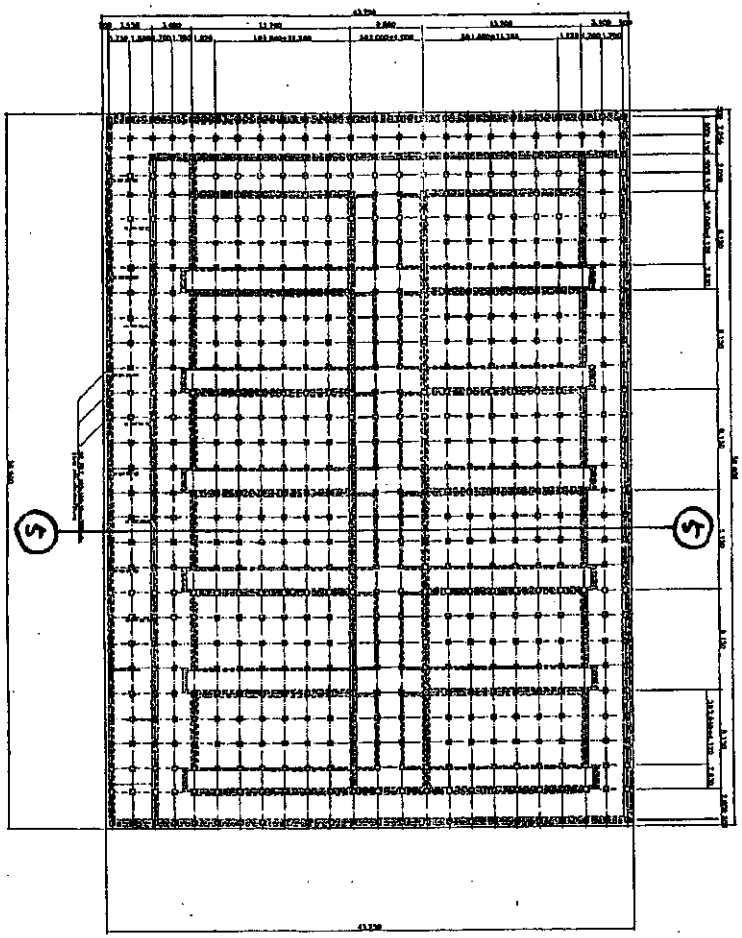


SECTION A–A
РАЗРЕЗ А-А

SECTION B–B
РАЗРЕЗ В-В

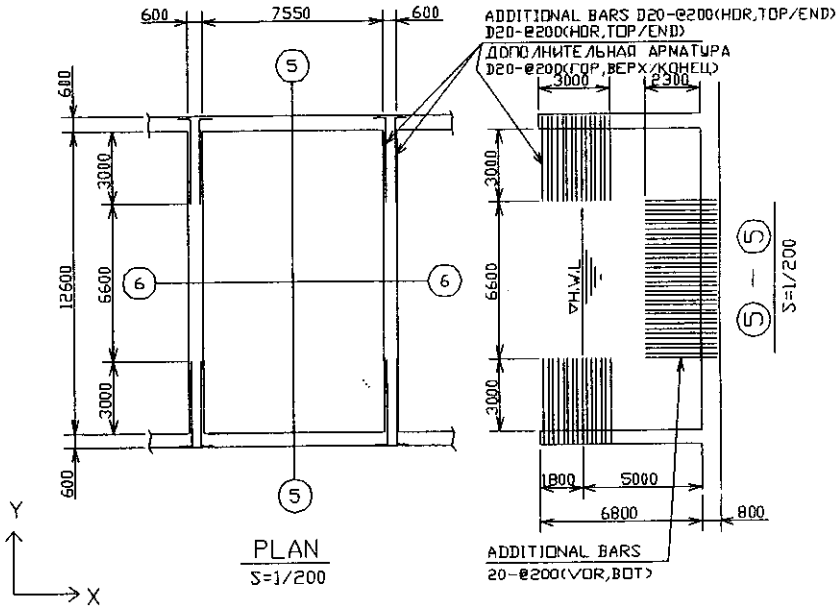
4-5

4.2 DESIGN OF WALL & FOOTING
4.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ



PILE ARRANGEMENT
РАССТАНОВКА СВАИ

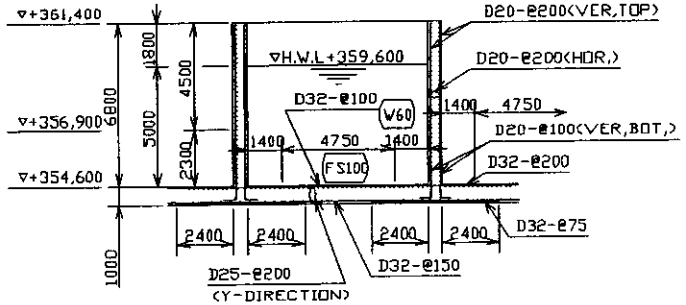
A.7-23



PLAN
S=1/200

(5) - (5)
S=1/200

ADDITIONAL BARS
20-@200(VOR,BOT)

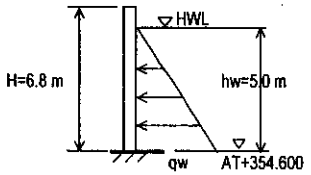


(6) - (6)
S=1/200

4.2.1 CALCULATION OF WALL (W60) ⑤-⑤

(AT+354.600)

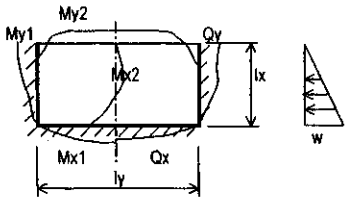
1) DESIGN LOAD (Water Pressure)



hw = = 5.00 m
γw= = 10.0 KN/m3

qw = γw · hw = 50.0 KN/m2/m

2) FACTORED STRESS (W60)



lx = 5.00 m
ly = 12.60 m
λ = 2.52
w=qw = 50.0 KN/m2/m

Factored Load
w'=1.4 · w = 70.00 KN/m2/m

w' · lx^2 = 1750.0
w' · lx = 350.0

SEE Fig.

Mx1 = 0.105 x 1750.0 = 183.8 (KN · m/m)
Mx2 = 0.013 x 1750.0 = 22.8
My1 = 0.082 x 1750.0 = 143.5
My2 = 0.026 x 1750.0 = 45.5

Qx = 0.50 x 350.0 = 175.0 (KN/m)
Qy = 0.28 x 350.0 = 98.0

3) DESIGN OF SECTION

a) VERTICAL : BOT (AT+354.600)

Mu = 183.8 KN·m
Vu = 175 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.021 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 527
Z2 = 0.95 · d = 513
Z = 513
As 1 = Mu /0.95·fy · Z = 1033 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2) Bottom
D 20 @ 200 (As = 1570 mm2) Top

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.32 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.58 < 3.0
400/d = 0.74 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.56 N/mm2 > V = 0.32 N/mm2 OK

b) HORIZONTAL : TOP/END

Mu = 143.5 KN·m
Vu = 98 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.018 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 510
Z2 = 0.95 · d = 494
Z = 494
As 1 = Mu /0.95·fy · Z = 838 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2) Top/End
D 20 @ 200 (As = 1570 mm2) Center,Bot/End

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.19 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.60 < 3.0
400/d = 0.77 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.57 N/mm2 > V = 0.19 N/mm2 OK

4) CHECK OF CRACKING ⑤-⑤
W60 (VERTICAL:BOT./HORIZONTAL:END)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @100 (As = 3140 mm2)
USE ; HORIZONTAL D 20 @100 (As = 3140 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Ver. Mu = 183.8 KN・m M = 131.3 KN・m b = 1000 mm
Hor. Mu = 143.5 KN・m M = 102.5 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.015
Z1 = dv・[0.5 + √{ 0.25−K/0.9)] = 531
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 1968.8 mm2

USE ; D 20 @100 (As = 3140 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0.0126
Z1 = dh・{0.5 + √{ 0.25−K/0.9)} = 513
Z2 = 0.95・dh = 494
Z = 494
As = M / fy・Z = 1596.1 mm2

USE ; D 20 @100 (As = 3140 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 531.75 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 531.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0126
ρ(H) = As/b・d1 = 0.0126

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

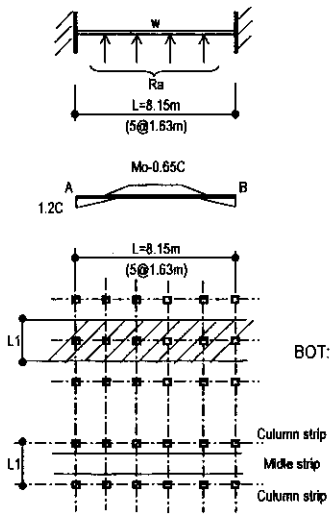
Wmax(V)= Smax(V)・(α/2)・T1 = 0.09 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.09 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 35 from TABLE 4.2

4.2.3 CALCULATION OF SLAB (S80) ⑤-⑤
(AT+354.600)

1) DESIGN LOAD & FACTORED STRESS



・Design load
D = 1.0 m
w =24.0・D・L1 = 39.6 KN/m
・Factored Load w' = 1.4・w = 55.4 KN/m
・Pile Reaction Ra = 262 KN/pile
Ra' = 1.4・Ra = 367 KN/pile

・Factored stress
L = 8.15 m
C=(2/5・Ra'・L)-(1/12・w'・L^2) = 888.9 KN・m
Mo=(3/5・Ra'・L)-(1/8・w'・L^2) = 1333.3 KN・m

M_A = 1.2・C = 1066.7 KN・m
Mo-0.65C = 755.6 KN・m
Vu =(4/2・Ra') -(1/2・w'・L) = 507.7 KN

・Column strip
L1 = 1.65 m
BOT: Mu1=0.375・(1.2・C)/(1/4・L1) = 969.7 KN・m
TOP: Mu2=0.375・(Mo-0.65・C)/(1/4・L1) = 686.9 KN・m

2) DESIGN OF SECTION (X-Direction)

a) HORIZONTAL : BOT/END

Mu = 969.7 KN·m
Vu = 507.7 KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 940 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.037 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 900
Z2 = 0.95 · d = 893
Z = 893
As 1 = Mu /0.95·fy · Z = 3132 mm2
Asmin = 0.0013 · b · D = 1300 mm2

USE ; D 32 @ 75 (As = 10720 mm2)
D 25 @ 200 (Y-Direction)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.54 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 1.14 < 3.0
400/d = 0.4 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.70 N/mm2 > V = 0.59 N/mm2 OK

b) HORIZONTAL : TOP/CENT

Mu = 686.9 KN·m
Vu = KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 920 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.027 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 891
Z2 = 0.95 · d = 874
Z = 874
As 1 = Mu /0.95·fy · Z = 2266 mm2
Asmin = 0.0013 · b · D = 1300 mm2

USE ; D 32 @ 100 (As = 8040 mm2)
D 25 @ 200 (Y-Direction)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.00 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.87 < 3.0
400/d = 0.4 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.64 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING (5)-(5)
FOOTING SLAB (FS80)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 1000 mm d(B) = 100 mm
d = 640 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ· b· d(T) = 875 mm2
As (bot) = ρ· b· d(B) = 350 mm2

USE ; TOP D 32 @ 100 (As = 8040 mm2)
USE ; BOTTOM D 32 @ 75 (As = 10720 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top Mu = 686.9 KN·m M = 490.6 KN·m b = 1000 mm
Bott. Mu = 969.7 KN·m M = 692.6 KN·m D = 1000 mm
d = 640 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.04
Z1 = d · [0.5 + √(0.25−K/0.9)] = 610
Z2 = 0.95·d = 608
Z = 608
As = M / fy · Z = 6207 mm2

USE ; D 32 @ 100 (As = 8040 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.056
Z1 = d · [0.5 + √(0.25−K/0.9)] = 597
Z2 = 0.95·d = 608
Z = 597
As = M / fy · Z = 8924 mm2

USE ; D 32 @ 75 (As = 10720 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 332.92 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 100.0 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0322
ρ(B) = As/b·d(B) = 0.1072

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

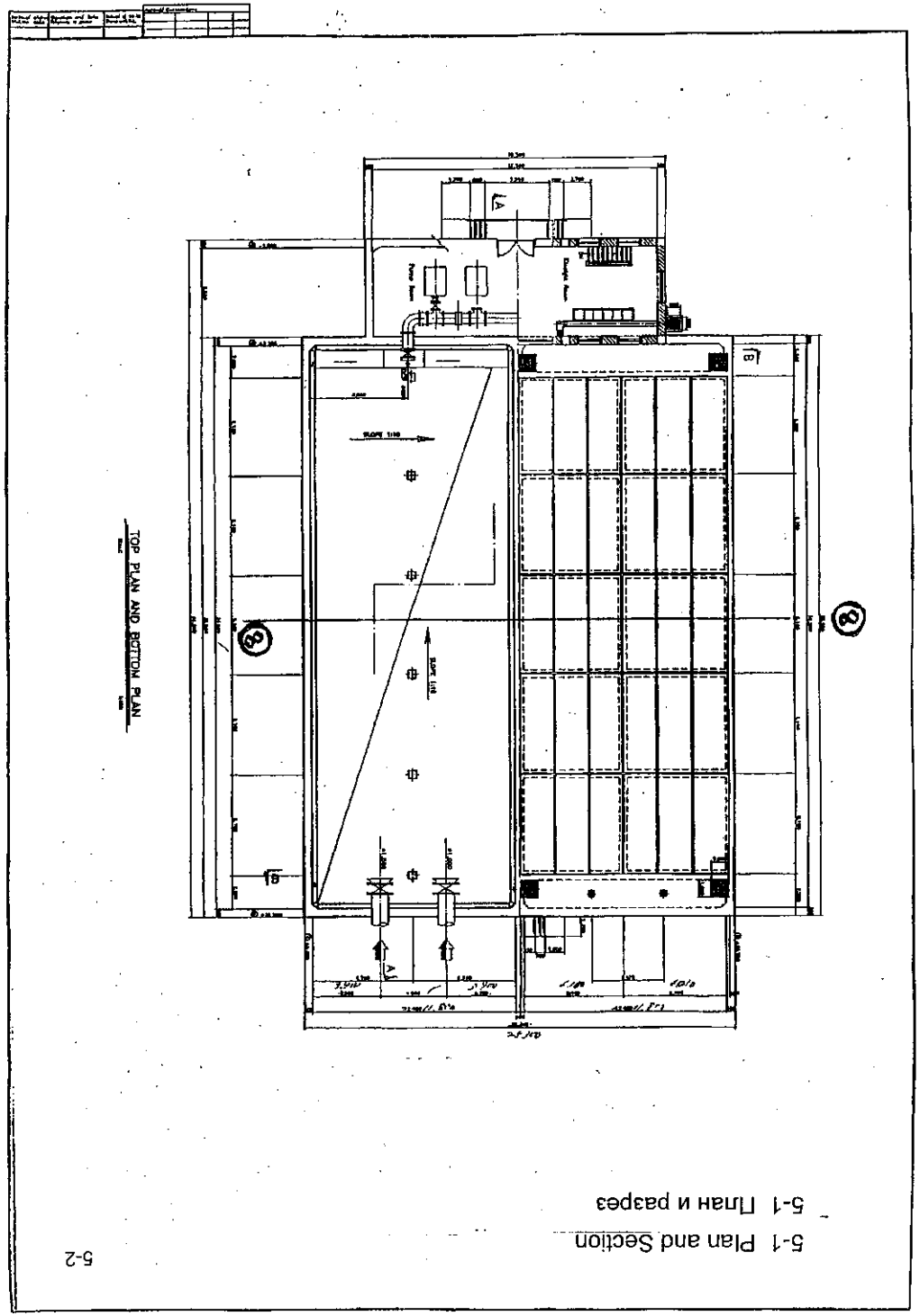
Wmax(T)= Smax(T)·(α/2)·T1 = 0.04 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.01 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

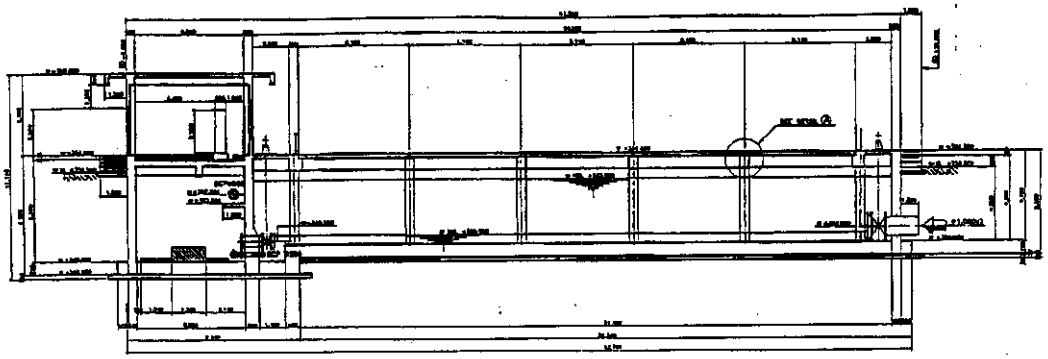
5. BACKWASH DRAINAGE BASIN

5. ПРОМЫВНОЙ ДРЕНАЖНЫЙ БАССЕЙН

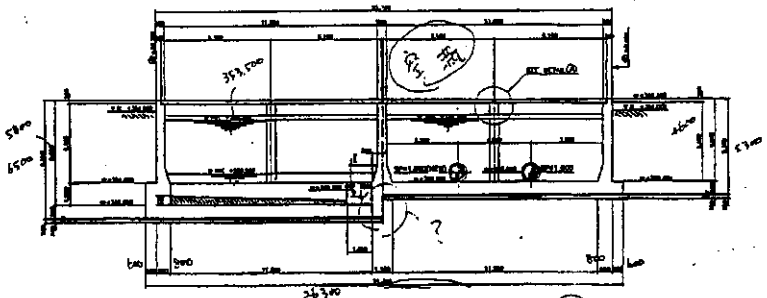


5-1 Plan and Section

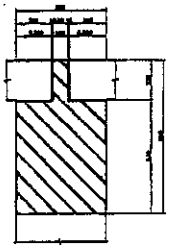
5-1 План и разрез



SECTION A–A

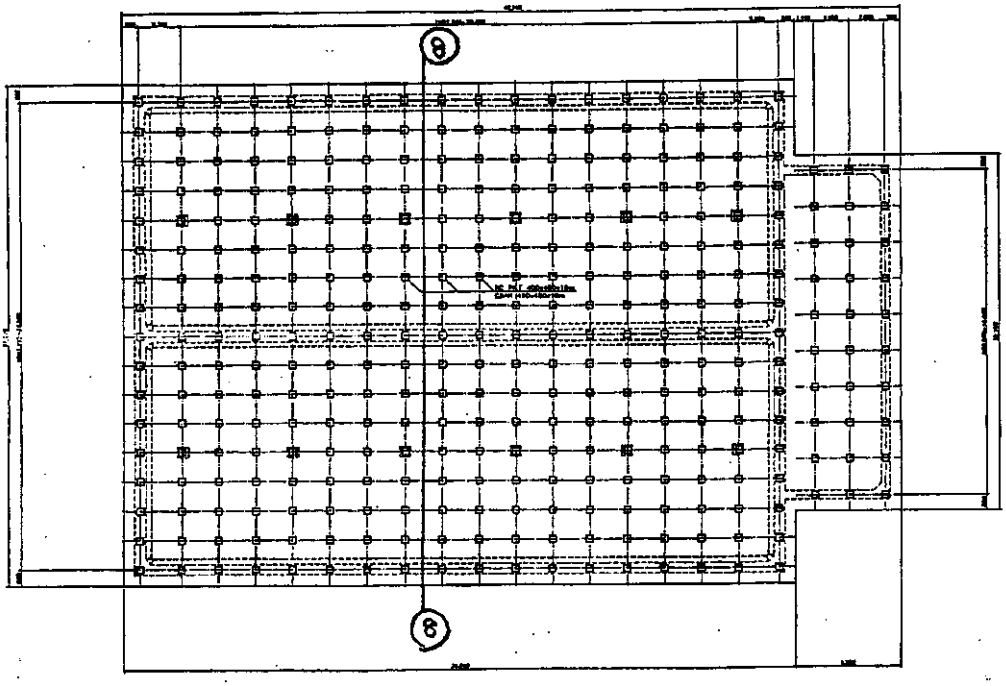


SECTION B–B



DETAIL Ⓐ

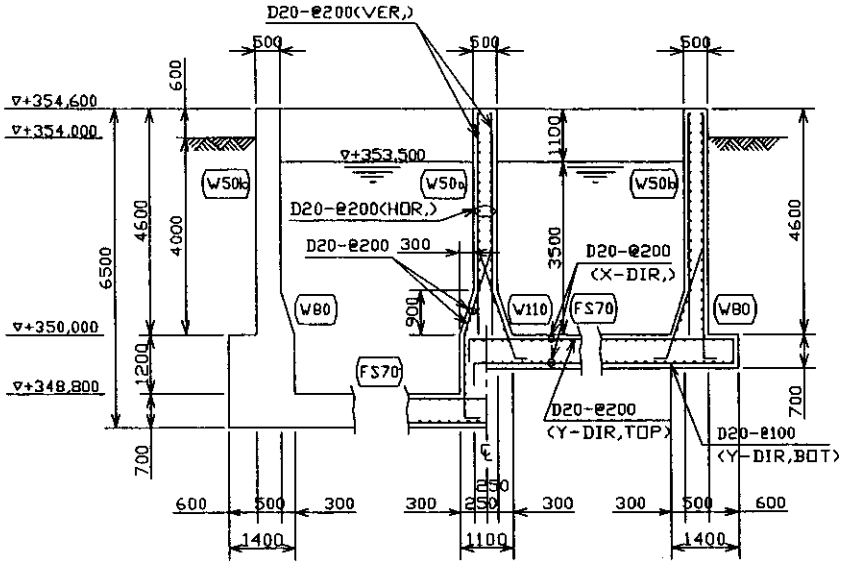
5-3



PILE ARRANGEMENT
РАССТАНОВКА СВАЙ

5-4

5.2 DESIGN OF WALL & FOOTING
5.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ

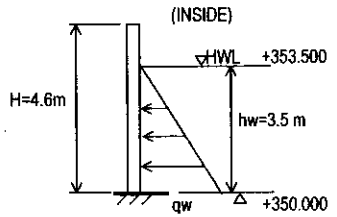


⑧ – ⑧
S=1/100

A.7-29

5.2.1 CALCULATION OF WALL (W80) ⑧-⑧
(AT+350.000)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 4.6 m
hw= 3.50 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 3.50 = 35.0 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 35.0 = 49.00 (KN/m2/m)

・Factered stress at +350.000

Mu = 1/6・w'・hw^2 = 100.0 (KN・m/m)
Vu = 1/2・w'・hw = 85.8 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL BOT.)

Mu = 100.0 KN・m
Vu = 85.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 800 mm fcu = 30 N/mm2
d = 740 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.006 < 0.156
Z1 = d・[0.5 + √(0.25 − K/0.9)] = 735
Z2 = 0.95・d = 703
Z = 703
As1 = Mu /0.95・fy・Z = 410 mm2
Asmin = 0.0013・b・D = 1040 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.12 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.21 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.40 N/mm2 > V = 0.12 N/mm2 OK

3) CHECK OF CRACKING (8)-(8)

W80 (INSIDE/VERTICAL;BOT) (AT+350.000)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 800 mm
dv = 740 mm
dh = 720 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 100.0 KN・m M = 71.5 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 800 mm
dv = 740 mm
dh = 720 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.0043
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 736
Z2 = 0.95・dv = 703
Z = 703
As = M / fy・Z = 781.91 mm2

USE ; D 20 @200 (As = 1570 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

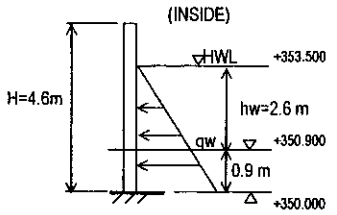
Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

5.2.2 CALCULATION OF WALL (W50a) ⑧-⑧
(AT+350.900)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 4.60 m
hw= 2.60 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 2.60 = 26.0 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 26.0 = 36.40 (KN/m2/m)

・Factered stress at +350.900

Mu = 1/6・w'・hw^2 = 41.0 (KN・m/m)
Vu = 1/2・w'・hw = 47.3 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL TOP)

Mu = 41.0 KN・m
Vu = 47.3 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]
K = Mu / (fcu・b・d^2) = 0.007 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 437
Z2 = 0.95・d = 418
Z = 418
As1 = Mu /0.95・fy・Z = 283 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.11 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.36 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・{ 400/d }^1/4・(1/1.25)・(fcu/25)^1/3
= 0.48 N/mm2 > V = 0.11 N/mm2 OK

3) CHECK OF CRACKING ⑧-⑧

W50a (INSIDE/VERTICAL:TOP) (AT+350.900)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 500 mm
dv = 440 mm
dh = 420 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 41.0 KN・m M = 29.3 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 500 mm
dv = 440 mm
dh = 420 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.005
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 438
Z2 = 0.95・dv = 418
Z = 418
As = M / fy・Z = 539.07 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

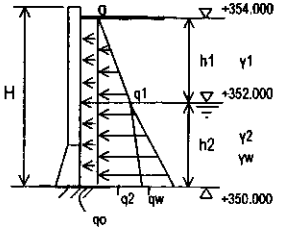
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

5.2.3 CALCULATION OF WALL (W80) ⑧-⑧
(AT+350.000)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

(OUTSIDE)



Ground Water Level at +352.000

H= 4.6 m
h1= 2.00 m
h2= 2.00 m
h=h1+h2= 4.00 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load

qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 26.0
qw = γw・h2 = 20.0
Σq = q2 + qw = 46.0

・Factered Load

w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 64.4

・Factered stress at +350.000

Mu1 = 1/2・w1・h^2 = 28.00 (KN・m/m)
Vu1 = w1・h = 14.00 (KN/m)
Mu2 = 1/6・w2・h^2 = 171.73 (KN・m/m)
Vu2 = 1/2・w2・h = 128.80 (KN/m)

Mu = Mu1 + Mu2 = 199.7 (KN・m/m)
Vu = Vu1 + Vu2 = 142.6 (KN/m)

2) DESIGN OF SECTION (OUTSIDE/VERTICAL TOP)

Mu = 199.7 KN・m
Vu = 142.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 800 mm fcu = 30 N/mm2
d = 740 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.012 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 730
Z2 = 0.95・d = 703
Z = 703
As1 = Mu /0.95・fy・Z = 819 mm2
Asmin = 0.0013・b・D = 1040 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.19 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.21 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.40 N/mm2 > V = 0.19 N/mm2 OK

3) CHECK OF CRACKING ⑧-⑧

W80 (OUTSIDE/VERTICAL:BOT) (AT+350.000)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 800 mm
dv = 740 mm
dh = 720 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ;	VERTICAL	D 20	@200	(As = 1570 mm2)
USE ;	HORIZONTAL	D 20	@200	(As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 199.7 KN・m M = 142.7 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 800 mm
dv = 740 mm
dh = 720 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0087
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 733
Z2 = 0.95・dv = 703
Z = 703
As = M / fy・Z = 1561.1 mm2

USE ; D 20 @200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

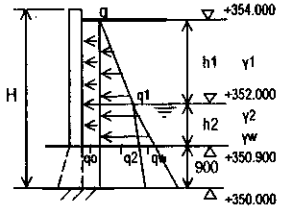
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

5.2.4 CALCULATION OF WALL (W50b) ⑧-⑧
(AT+350.900)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

(OUTSIDE)



Ground Water Level at +352.000

H= 4.6 m
h1= 2.00 m
h2= 1.10 m
h=h1+h2= 3.10 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load

qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 22.4
qw = γw・h2 = 11.0
Σq = q2 + qw = 33.4

・Factered Load

w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 46.8

・Factered stress at +350.900

Mu1 = 1/2・w1・h^2 = 16.82 (KN・m/m)
Vu1 = w1・h = 10.85 (KN/m)
Mu2 = 1/6・w2・h^2 = 74.89 (KN・m/m)
Vu2 = 1/2・w2・h = 72.48 (KN/m)

Mu = Mu1 + Mu2 = 91.7 (KN・m/m)
Vu = Vu1 + Vu2 = 83.3 (KN/m)

2) DESIGN OF SECTION (OUTSIDE/VERTICAL TOP)

Mu = 91.7 KN・m
Vu = 83.3 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.016 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 432
Z2 = 0.95・d = 418
Z = 418
As1 = Mu /0.95・fy・Z = 633 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.19 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.36 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.48 N/mm2 > V = 0.19 N/mm2 OK

3) CHECK OF CRACKING ⑧-⑧

W50b (OUTSIDE/VERTICAL;TOP) (AT+350.900)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 500 mm
dv = 440 mm
dh = 420 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver.	Mu =	91.7	KN・m	M =	65.5	KN・m	b = 1000 mm
Hor.	Mu =	0.0	KN・m	M =	0.0	KN・m	D = 500 mm
							dv = 440 mm
							dh = 420 mm
							fy = 130 N/mm2
							fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0113
Z1 = dv・[0.5 + √(0.25 − K/0.9)] = 434
Z2 = 0.95・dv = 418
Z = 418
As = M / fy・Z = 1205.5 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25 − K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

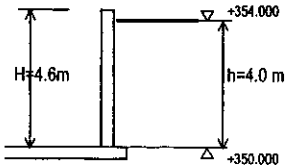
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

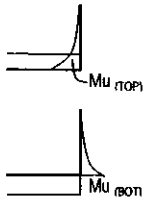
5.2.6 CALCULATION OF FOOTING SLAB (FS70) ⑧-⑧

(AT+350.000)

1) FACTORED STRESS



・Factered stress at +350.000



from Moment of Inside of Wall (refer to para75.2.1)
Mu (TOP) = 100.0 (KN・m/m)

from Moment of Outside of Wall (refer to para.7.2.3)
Mu (BOT) = 199.7 (KN・m/m)

2) DESIGN OF SECTION

	BOT		TOP	
Mu =	199.7	KN・m	(100.0	KN・m)
Vu =		KN/m		

b =	1000	mm	fy =	365 N/mm2
D =	700	mm	fcu =	30 N/mm2
d =	640	mm		

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.016 < 0.156
Z1 = d・[0.5 + √(0.25 − K/0.9)] = 628
Z2 = 0.95・d = 608
Z = 608
As1 = Mu /0.95・fy・Z = 947 mm2
Asmin = 0.0013・b・D = 910 mm2

USE ; D 20 @ 100 (As = 3140 mm2) BOT
(D 20 @ 200 As = 1570 mm2) TOP

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.00 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.49 < 3.0
400/d = 0.6 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.53 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING ⑧-⑧

FOOTING SLAB (FS70)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION	b =	1000	mm	SURFACE ZONE :	d(T) =	250	mm
	D =	700	mm		d(B) =	100	mm
	d =	640	mm				

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ· b· d(T) = 875 mm2
As (bot) = ρ· b· d(B) = 350 mm2

USE ;	TOP	D 20	@ 200	(As =	1570 mm2)
USE ;	BOTTOM	D 20	@ 100	(As =	3140 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Top	Mu =	100.0	KN·m	M =	71.5	KN·m	b =	1000 mm
Bott.	Mu =	199.7	KN·m	M =	142.7	KN·m	D =	700 mm
							d =	640 mm
							fy =	130 N/mm2
							fcu =	30 N/mm2

TOP

K = M / (fcu·b·d^2)	=	0.0058	
Z1 = d · [0.5 + √(0.25−K/0.9)]	=	636	
Z2 = 0.95·d	=	608	
Z =		608	
As = M / fy · Z	=	904.08	mm2

USE ; D 20 @ 200 (As = 1570 mm2)

BOTTOM

K = M / (fcu·b·d^2)	=	0.0116	
Z1 = d · [0.5 + √(0.25−K/0.9)]	=	632	
Z2 = 0.95·d	=	608	
Z =		608	
As = M / fy · Z	=	1805	mm2

USE ; D 20 @ 100 (As = 3140 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T))	=	1066.9	mm		
Smax(B) = (fct/fb)·(φ/2ρ(B))	=	213.4	mm		
Where ; fct/fb = 0.67	ρ(T) =	As/b·d(T) =	0.0063		
	ρ(B) =	As/b·d(B) =	0.0314		

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

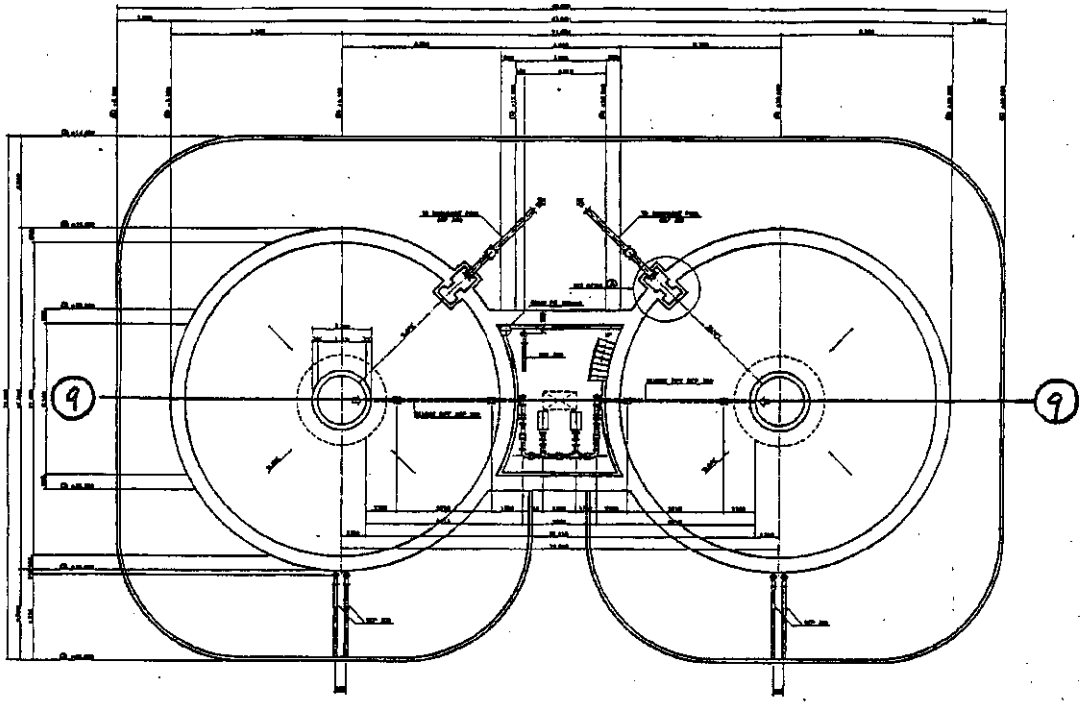
Wmax(T)= Smax(T)·(α/2)·T1	=	0.13	<	0.2	mm
Wmax(B)= Smax(B)·(α/2)·T1	=	0.03	<	0.2	mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

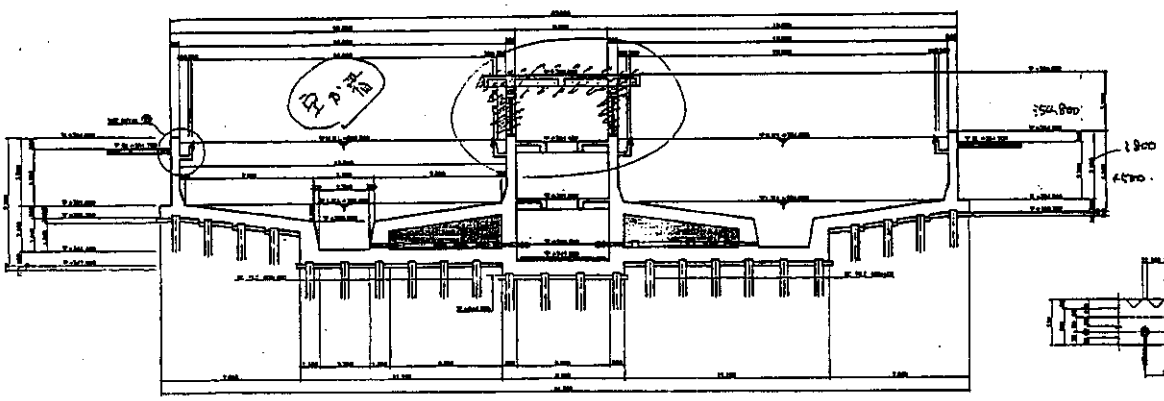
α= 1E-05
T1= 25 from TABLE 4.2

6. SLUDGE THICKENER

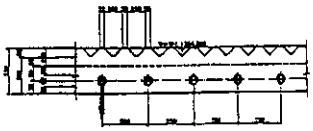
6. ИЛОУПЛОТНИТЕЛЬ



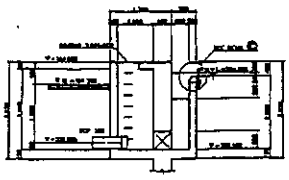
BOTTOM PLAN



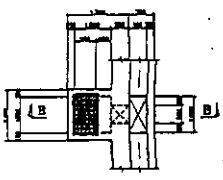
⑨-⑨ SECTION A-A



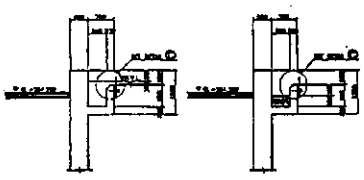
SECTION C-C



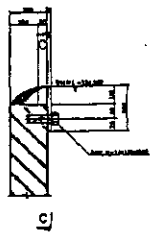
SECTION B-B



MANHOLE



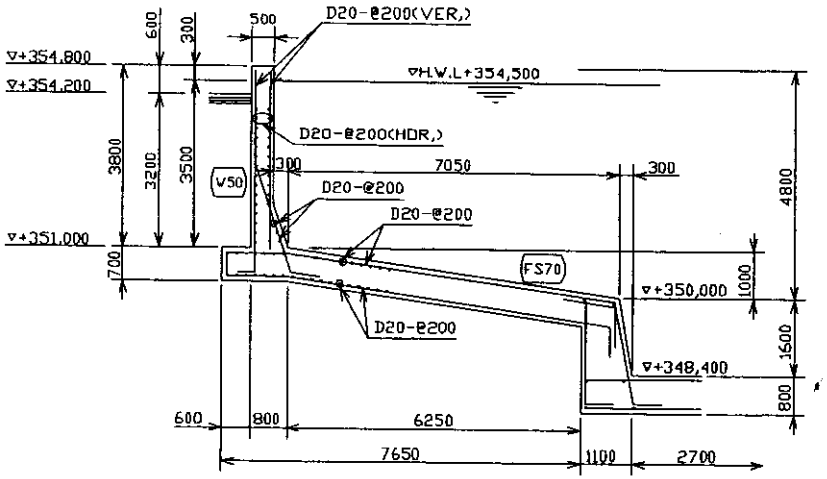
DETAIL (B)



DETAIL (C)

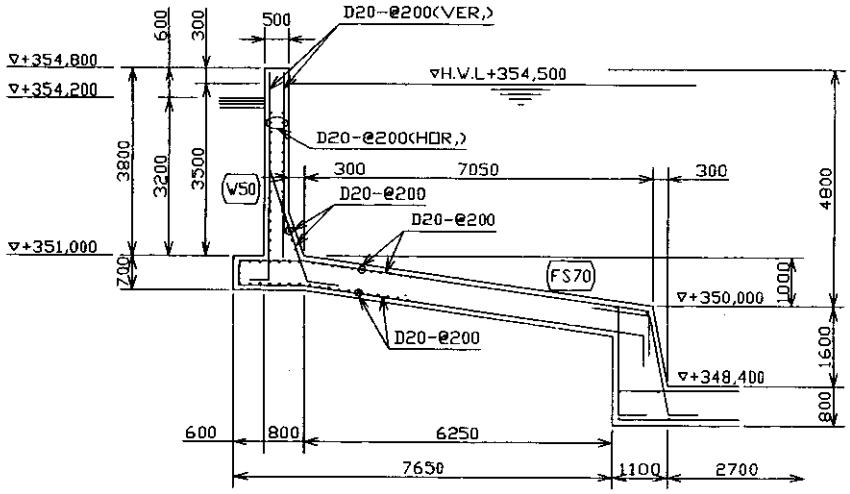
DETAIL (A)

6.2 DESIGN OF WALL & FOOTING SLAB
6.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ПЛИТЫ ОСНОВАНИЯ



⑨ – ⑨
S=1/100

6.2 DESIGN OF WALL & FOOTING SLAB
6.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ПЛИТЫ ОСНОВАНИЯ

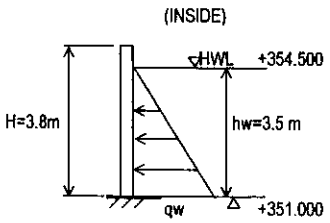


⑨ – ⑨
S=1/100

6.2.1 CALCULATION OF WALL (W50) ⑨-⑨

(AT+351.000)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 3.8 m
hw= 3.50 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 3.50 = 35.0 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 35.0 = 49.00 (KN/m2/m)

・Factered stress at +351.000

Mu = 1/6・w'・hw^2 = 100.0 (KN・m/m)

Vu = 1/2・w'・hw = 85.8 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL BOT.)

Mu = 100.0 KN・m
Vu = 85.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.017 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 431
Z2 = 0.95・d = 418
Z = 418
As1 = Mu /0.95・fy・Z = 690 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.19 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.36 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・{ 400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.48 N/mm2 > V = 0.19 N/mm2 OK

3) CHECK OF CRACKING ⑨-⑨

W50 (INSIDE/VERTICAL:BOT)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 500 mm
dv = 440 mm
dh = 420 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 100.0 KN・m M = 71.5 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 500 mm
dv = 440 mm
dh = 420 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.012
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 434
Z2 = 0.95・dv = 418
Z = 418
As = M / fy・Z = 1315 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) =
Z1 = dh・[0.5 + √(0.25−K/0.9)] =
Z2 = 0.95・dh =
Z =
As = M / fy・Z = mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

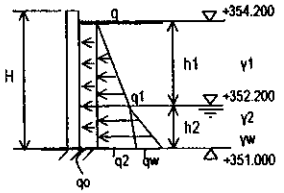
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

6.2.2 CALCULATION OF WALL (W50) ⑨-⑨

(AT+351.000)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)



Ground Water Level at +352.200

H= 3.8 m
h1= 2.00 m
h2= 1.20 m
h=h1+h2= 3.20 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load

qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 22.8
qw = γw・h2 = 12.0
Σq = q2 + qw = 34.8

・Factered Load

w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 48.7

・Factered stress at +351.000

Mu1 = 1/2・w1・h^2 = 17.92 (KN・m/m)
Vu1 = w1・h = 11.20 (KN/m)
Mu2 = 1/6・w2・h^2 = 83.15 (KN・m/m)
Vu2 = 1/2・w2・h = 77.95 (KN/m)

Mu = Mu1 + Mu2 = 101.1 (KN・m/m)
Vu = Vu1 + Vu2 = 89.2 (KN/m)

2) DESIGN OF SECTION (OUTSIDE/VERTICAL BOT.)

Mu = 101.1 KN・m
Vu = 89.2 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.017 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 431
Z2 = 0.95・d = 418
Z = 418
As1 = Mu /0.95・fy・Z = 697 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.20 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.71 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.60 N/mm2 > V = 0.20 N/mm2 OK

3) CHECK OF CRACKING ⑨-⑨

W50 (OUTSIDE/VERTICAL:BOT)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 500 mm
dv = 440 mm
dh = 420 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 101.1 KN・m M = 72.2 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 500 mm
dv = 440 mm
dh = 420 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0124
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 434
Z2 = 0.95・dv = 418
Z = 418
As = M / fy・Z = 1328.5 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

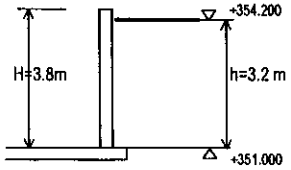
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

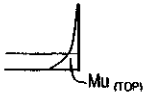
α= 1E-05
T1= 32 from TABLE 4.2

6.2.3 CALCULATION OF FOOTING SLAB (FS70) ⑨-⑨

(AT+351.000)

1) FACTORED STRESS





・Factered stress at +351.000

from Moment of Inside of Wall (refer to para.5.2.1)

$Mu_{(TOP)}$ = 100.0 (KN・m/m)

from Moment of Outside of Wall (refer to para.5.2.2)

$Mu_{(BOT)}$ = 101.1 (KN・m/m)

2) DESIGN OF SECTION

	BOT		TOP
Mu =	101.1	KN・m	(100.0 KN・m)
Vu =		KN/m	

b =	1000	mm	fy =	365 N/mm2
D =	700	mm	fcu =	30 N/mm2
d =	640	mm		

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2)	=	0.008 < 0.156	
Z1 = d・[0.5 + √(0.25−K/0.9)]	=	634	
Z2 = 0.95・d	=	608	
Z =		608	
As1 = Mu /0.95・fy・Z	=	479	mm2
Asmin = 0.0013・b・D	=	910	mm2

USE ; D 20 @ 200 (As = 1570 mm2) BOT

(D 20 @ 200 As = 1570 mm2) TOP

[CHECK OF SHEAR STRESS]

V = Vu /(b・d)	=	0.00	<	4.4 N/mm2	OK
(100・As)/(b・d)	=	0.25	<	3.0	
400/d	=	0.6	<	1.0 →	1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3

= 0.42 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING ⑨-⑨

FOOTING SLAB (FS70)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION	b =	1000	mm	SURFACE ZONE :	d(T) =	250 mm
	D =	700	mm		d(B) =	100 mm
	d =	640	mm			

Min. ρ = 0.0035 (0.35 %)

As (top) =	ρ・ b・ d(T) =	875	mm2
As (bot) =	ρ・ b・ d(B) =	350	mm2

USE ; TOP D 20 @ 200 (As = 1570 mm2)

USE ; BOTTOM D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Top	Mu =	100.0	KN・m	M =	71.5	KN・m	b =	1000 mm
Bott.	Mu =	101.1	KN・m	M =	72.2	KN・m	D =	700 mm
							d =	640 mm
							fy =	130 N/mm2
							fcu =	30 N/mm2

TOP

K = M / (fcu・b・d^2)	=	0.0058	
Z1 = d・[0.5 + √(0.25−K/0.9)]	=	636	
Z2 = 0.95・d	=	608	
Z =		608	
As = M / fy・Z	=	904.08	mm2

USE ; D 20 @ 200 (As = 1570 mm2)

BOTTOM

K = M / (fcu・b・d^2)	=	0.0059	
Z1 = d・[0.5 + √(0.25−K/0.9)]	=	636	
Z2 = 0.95・d	=	608	
Z =		608	
As = M / fy・Z	=	913.36	mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)・(φ/2ρ(T))	=	1066.9	mm		
Smax(B) = (fct/fb)・(φ/2ρ(B))	=	426.8	mm		
Where ; fct/fb = 0.67	ρ(T) =	As/b・d(T)	=	0.0063	
	ρ(B) =	As/b・d(B)	=	0.0157	

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)・(α/2)・T1	=	0.13	<	0.2	mm
Wmax(B)= Smax(B)・(α/2)・T1	=	0.05	<	0.2	mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05

T1= 25 from TABLE 4.2

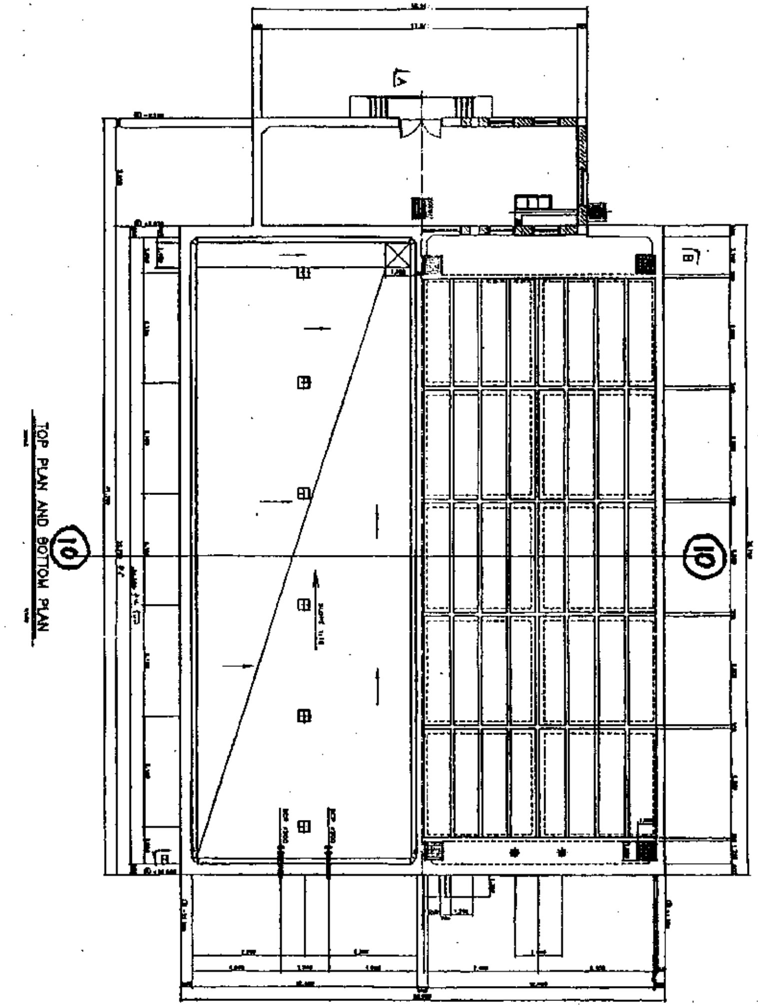
7-1

7. DISCHARGE POOL

7. НАКОПИТЕЛЬНЫЙ РЕЗЕРВУАР

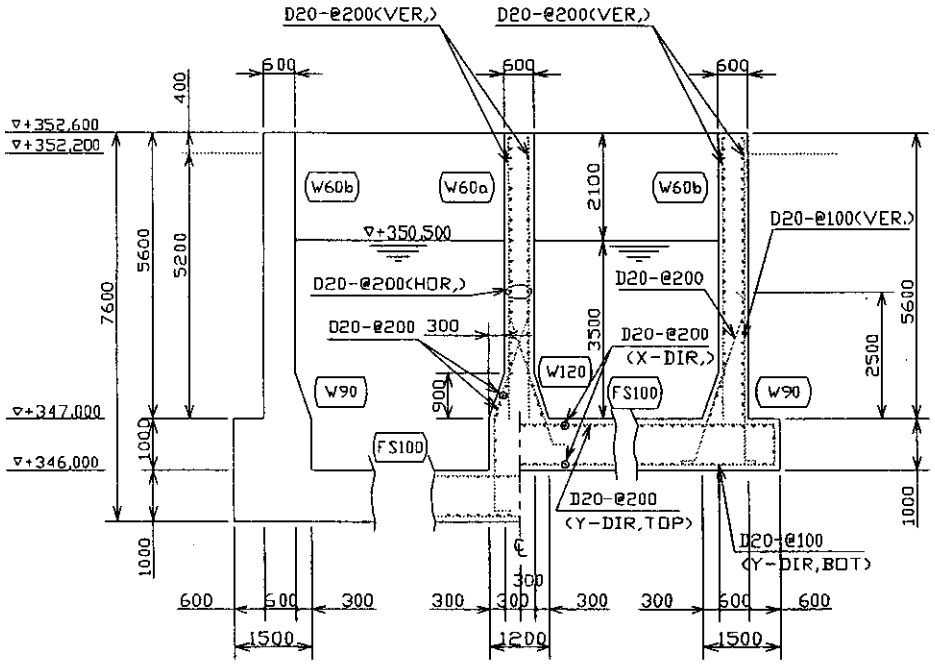
7-1 Plan and Section

7-1 План и разрез

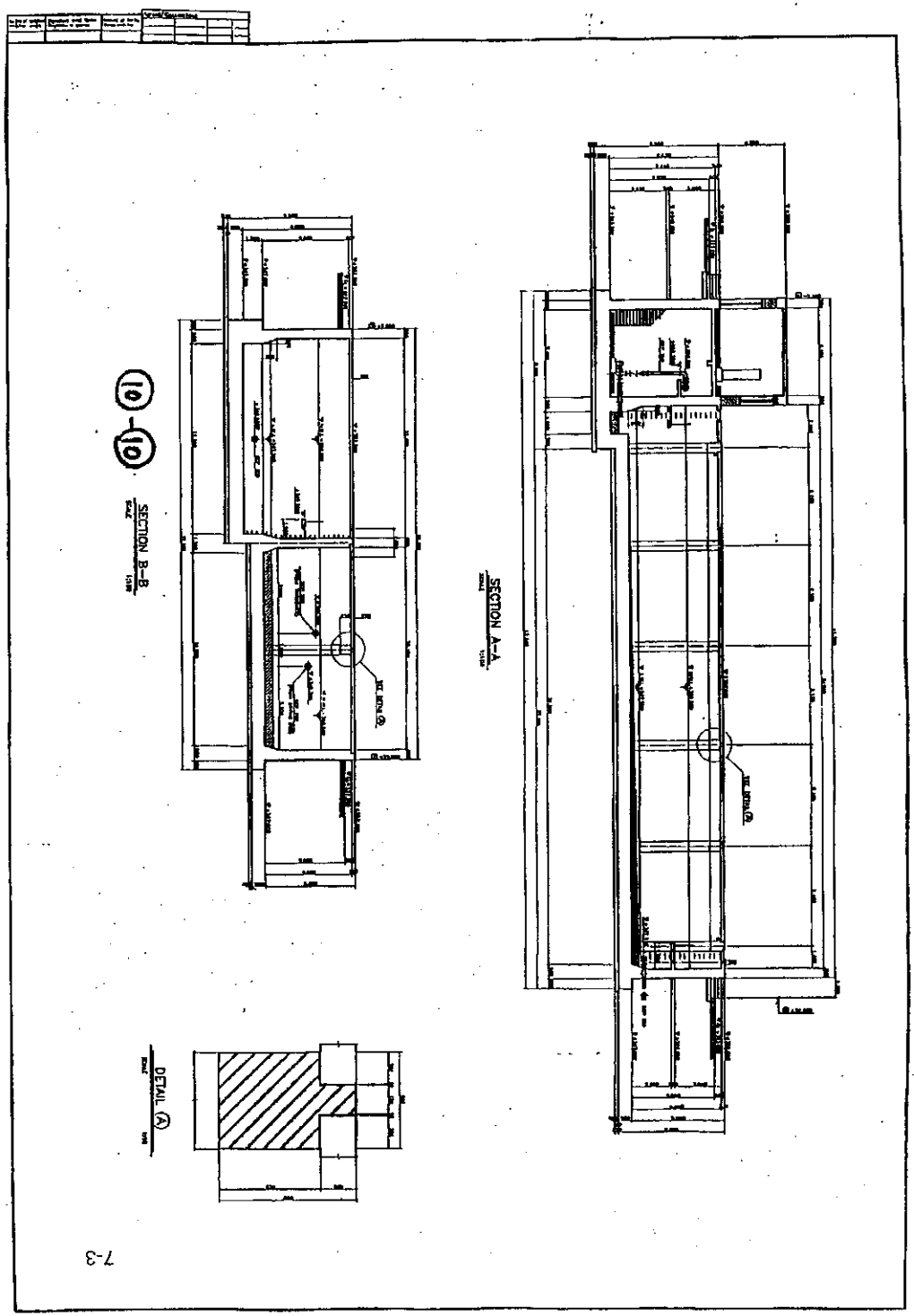


7-2

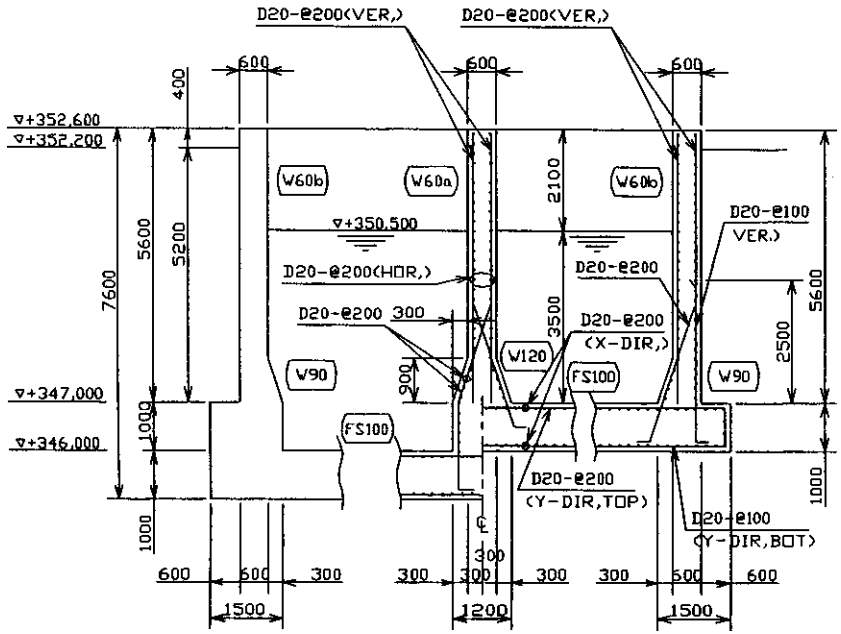
7.2 DESIGN OF WALL & FOOTING
7.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ



⑩ — ⑩
S=1/100



7.2 DESIGN OF WALL & FOOTING
7.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ

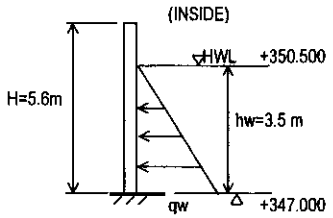


⑩ — ⑩
S=1/100

A.7-42

7.2.1 CALCULATION OF WALL (W90) ⑩-⑩
(AT+347.000)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 5.60 m
hw= 3.50 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 3.50 = 35.0 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 35.0 = 49.00 (KN/m2/m)

・Factered stress at +347.000

Mu = 1/6・w'・hw^2 = 100.0 (KN・m/m)
Vu = 1/2・w'・hw = 85.8 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL BOT.)

Mu = 100.0 KN・m
Vu = 85.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 900 mm fcu = 30 N/mm2
d = 840 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.005 < 0.156
Z1 = d・ [0.5 + √(0.25 − K/0.9)] = 836
Z2 = 0.95・d = 798
Z = 798
As1 = Mu /0.95・fy・Z = 362 mm2
Asmin = 0.0013・b・D = 1170 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.10 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.19 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79・[(100・As)/(b・d)]^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.38 N/mm2 > V = 0.10 N/mm2 OK

3) CHECK OF CRACKING ⑩-⑩

W90 (INSIDE/VERTICAL:BOT) (AT+347.000)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 900 mm
dv = 840 mm
dh = 820 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 100.0 KN・m M = 71.4 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 900 mm
dv = 840 mm
dh = 820 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.0034
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 837
Z2 = 0.95・dv = 798
Z = 798
As = M / fy・Z = 688.26 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

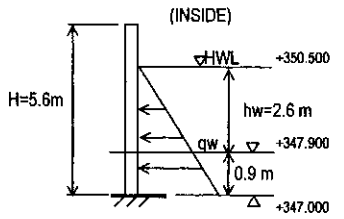
Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

7.2.2 CALCULATION OF WALL (W60a) ⑩-⑩
(AT+347.900)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 5.60 m
hw= 2.60 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 2.60 = 26.0 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 26.0 = 36.40 (KN/m2/m)

・Factered stress at +347.900

Mu = 1/6・w'・hw^2 = 41.0 (KN・m/m)
Vu = 1/2・w'・hw = 47.3 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL TOP)

Mu = 41.0 KN・m
Vu = 47.3 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]
K = Mu / (fcu・b・d^2) = 0.005 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 537
Z2 = 0.95・d = 513
Z = 513
As1 = Mu /0.95・fy・Z = 231 mm2
Asmin = 0.0013・b・D = 780 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.09 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.29 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.45 N/mm2 > V = 0.09 N/mm2 OK

3) CHECK OF CRACKING ⑩-⑩

W60a (INSIDE/VERTICAL:TOP) (AT+347.900)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 41.0 KN・m M = 29.3 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.0033
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 538
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 439.35 mm2

USE ; D 20 @200 (As = 1570 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

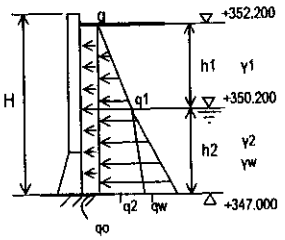
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

7.2.3 CALCULATION OF WALL (W90) ⑩-⑩
(AT+347.000)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

(OUTSIDE)



Ground Water Level at +350.200

H= 5.6 m
h1= 2.00 m
h2= 3.20 m
h=h1+h2= 5.20 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load
qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 30.8
qw = γw・h2 = 32.0
Σq = q2 + qw = 62.8

・Factered Load
w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 87.9

・Factered stress at +347.000
Mu1 = 1/2・w1・h^2 = 47.32 (KN・m/m)
Vu1 = w1・h = 18.20 (KN/m)
Mu2 = 1/6・w2・h^2 = 396.23 (KN・m/m)
Vu2 = 1/2・w2・h = 228.59 (KN/m)

Mu = Mu1 + Mu2 = 443.5 (KN・m/m)
Vu = Vu1 + Vu2 = 246.8 (KN/m)

2) DESIGN OF SECTION (OUTIDE/VERTICAL BOT)

Mu = 443.5 KN・m
Vu = 246.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 900 mm fcu = 30 N/mm2
d = 840 mm

[REQUIRED RE-BAR]
K = Mu / (fcu・b・d^2) = 0.021 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 820
Z2 = 0.95・d = 798
Z = 798
As1 = Mu /0.95・fy・Z = 1603 mm2
Asmin = 0.0013・b・D = 1170 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.29 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.37 < 3.0
400/d = 0.5 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.48 N/mm2 > V = 0.29 N/mm2 OK

3) CHECK OF CRACKING ⑩-⑩

W90 (OUTSIDE/VERTICAL:BOT) (AT+347.000)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 900 mm
dv = 840 mm
dh = 820 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 100 (As = 3140 mm2)
USE ; HORIZONTAL D 20 @ 200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 443.5 KN・m M = 316.8 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 900 mm
dv = 840 mm
dh = 820 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.015
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 826
Z2 = 0.95・dv = 798
Z = 798
As = M / fy・Z = 3053.8 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 533.4 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0126
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.09 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

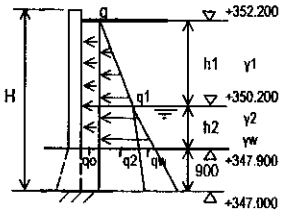
α= 1E-05
T1= 32 from TABLE 4.2

7.2.4 CALCULATION OF WALL (W60b) ⑩-⑩

(AT+347.900)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

(OUTSIDE)



Ground Water Level at +350.200

H= 5.6 m
h1= 2.00 m
h2= 2.30 m
h=h1+h2= 4.30 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load

qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 27.2
qw = γw・h2 = 23.0
Σq = q2 + qw = 50.2

・Factered Load

w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 70.3

・Factered stress at +347.900

Mu1 = 1/2・w1・h^2 = 32.36 (KN・m/m)
Vu1 = w1・h = 15.05 (KN/m)
Mu2 = 1/6・w2・h^2 = 216.58 (KN・m/m)
Vu2 = 1/2・w2・h = 151.10 (KN/m)

Mu = Mu1 + Mu2 = 248.9 (KN・m/m)
Vu = Vu1 + Vu2 = 166.2 (KN/m)

2) DESIGN OF SECTION (OUTIDE/VERTICAL BOT)

Mu = 248.9 KN・m
Vu = 166.2 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.028 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 522
Z2 = 0.95・d = 513
Z = 513
As1 = Mu /0.95・fy・Z = 1399 mm2
Asmin = 0.0013・b・D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.31 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.58 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.56 N/mm2 > V = 0.31 N/mm2 OK

3) CHECK OF CRACKING ⑩-⑩

W60b (OUTSIDE/VERTICAL:BOT) (AT+347.900)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ;	VERTICAL	D 20	@ 100	(As = 3140 mm2)
USE ;	HORIZONTAL	D 20	@ 200	(As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 248.9 KN・m M = 177.8 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0203
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 528
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 2666.1 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = {fct/fb)・(φ/2ρ(V)) = 533.4 mm
Smax(H) = {fct/fb)・(φ/2ρ(H)) = 1066.9 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0126
ρ(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.09 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

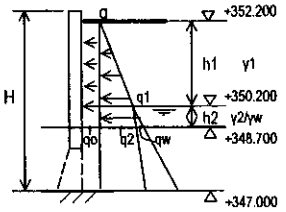
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

7.2.5 CALCULATION OF WALL (W60b) ⑩-⑩
(AT+348.700)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

(OUTSIDE)



Ground Water Level at +350.200

H= 5.6 m
h1= 2.00 m
h2= 1.50 m
h=h1+h2= 3.50 m

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

・Design load

qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 18.0
q2 = q1+Ko・γ2・h2 = 24.0
qw = γw・h2 = 15.0
Σq = q2 + qw = 39.0

・Factered Load

w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・Σq = 54.6

・Factered stress at +348.700

Mu1 = 1/2・w1・h^2 = 21.44 (KN・m/m)
Vu1 = w1・h = 12.25 (KN/m)
Mu2 = 1/6・w2・h^2 = 111.48 (KN・m/m)
Vu2 = 1/2・w2・h = 95.55 (KN/m)

Mu = Mu1 + Mu2 = 132.9 (KN・m/m)
Vu = Vu1 + Vu2 = 107.8 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL TOP)

Mu = 132.9 KN・m
Vu = 107.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.015 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 531
Z2 = 0.95・d = 513
Z = 513
As1 = Mu /0.95・fy・Z = 747 mm2
Asmin = 0.0013・b・D = 780 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.20 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.29 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.45 N/mm2 > V = 0.20 N/mm2 OK

3) CHECK OF CRACKING ⑩-⑩

W60b (OUTSIDE/VERTICAL:TOP) (AT+348.700)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ;	VERTICAL	D 20	@ 200	(As =	1570 mm2)
USE ;	HORIZONTAL	D 20	@ 200	(As =	1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver.	Mu =	132.9	KN・m	M =	94.9	KN・m	b =	1000 mm
Hor.	Mu =	0.0	KN・m	M =	0.0	KN・m	D =	600 mm
							dv =	540 mm
							dh =	520 mm
							fy =	130 N/mm2
							fcu =	30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0108
Z1 = dv・[0.5 + √(0.25—K/0.9)] = 533
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 1423 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25—K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fcl/fb)・(φ/2p(V)) = 1066.9 mm
Smax(H) = (fct/fb)・(φ/2p(H)) = 1066.9 mm

Where ; fct/fb = 0.67 p(V) = As/b・d1 = 0.0063
p(H) = As/b・d1 = 0.0063

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

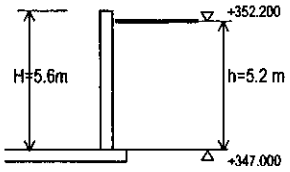
Wmax(V)= Smax(V)・(α/2)・T1 = 0.17 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.17 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 32 from TABLE 4.2

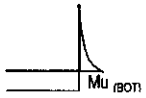
7.2.6 CALCULATION OF FOOTING SLAB (FS70) ⑩-⑩
(AT+347.000)

1) FACTORED STRESS



・Factered stress at +347.000

from Moment of Inside of Wall (refer to para75.2.1)
Mu (TOP) = 100.0 (KN・m/m)



from Moment of Outside of Wall (refer to para.7.2.3)
Mu (BOT) = 443.5 (KN・m/m)

2) DESIGN OF SECTION (BOTTOM BAR)

	BOT		TOP	
Mu =	443.5	KN・m	(100.0	KN・m)
Vu =		KN/m		

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 940 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.017 < 0.156
Z1 = d・[0.5 + √(0.25—K/0.9)] = 922
Z2 = 0.95・d = 893
Z = 893
As1 = Mu /0.95・fy・Z = 1432 mm2
Asmin = 0.0013・b・D = 1300 mm2

USE ;	D 20	@	100	(As =	3140	mm2)	BOT
(	D 20	@	200	As =	1570	mm2)	TOP

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.00 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.33 < 3.0
400/d = 0.4 < 1.0 → 1.0

Vc = 0.79・[(100・As)/(b・d)]^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.47 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING (10)-(10)

FOOTING SLAB (FS70)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 1000 mm d(B) = 100 mm
d = 940 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ · b · d(T) = 875 mm2
As (bot) = ρ · b · d(B) = 350 mm2

USE ; TOP D 20 @ 200 (As = 1570 mm2)
USE ; BOTTOM D 20 @ 100 (As = 3140 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Top Mu = 100.0 KN·m M = 71.4 KN·m b = 1000 mm
Bott. Mu = 443.5 KN·m M = 316.8 KN·m D = 1000 mm
d = 940 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.0027
Z1 = d · [0.5 + √(0.25 − K/0.9)] = 937
Z2 = 0.95·d = 893
Z = 893
As = M / fy · Z = 615.04 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.012
Z1 = d · [0.5 + √(0.25 − K/0.9)] = 927
Z2 = 0.95·d = 893
Z = 893
As = M / fy · Z = 2728.9 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 1066.9 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 213.4 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0063
ρ(B) = As/b·d(B) = 0.0314

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

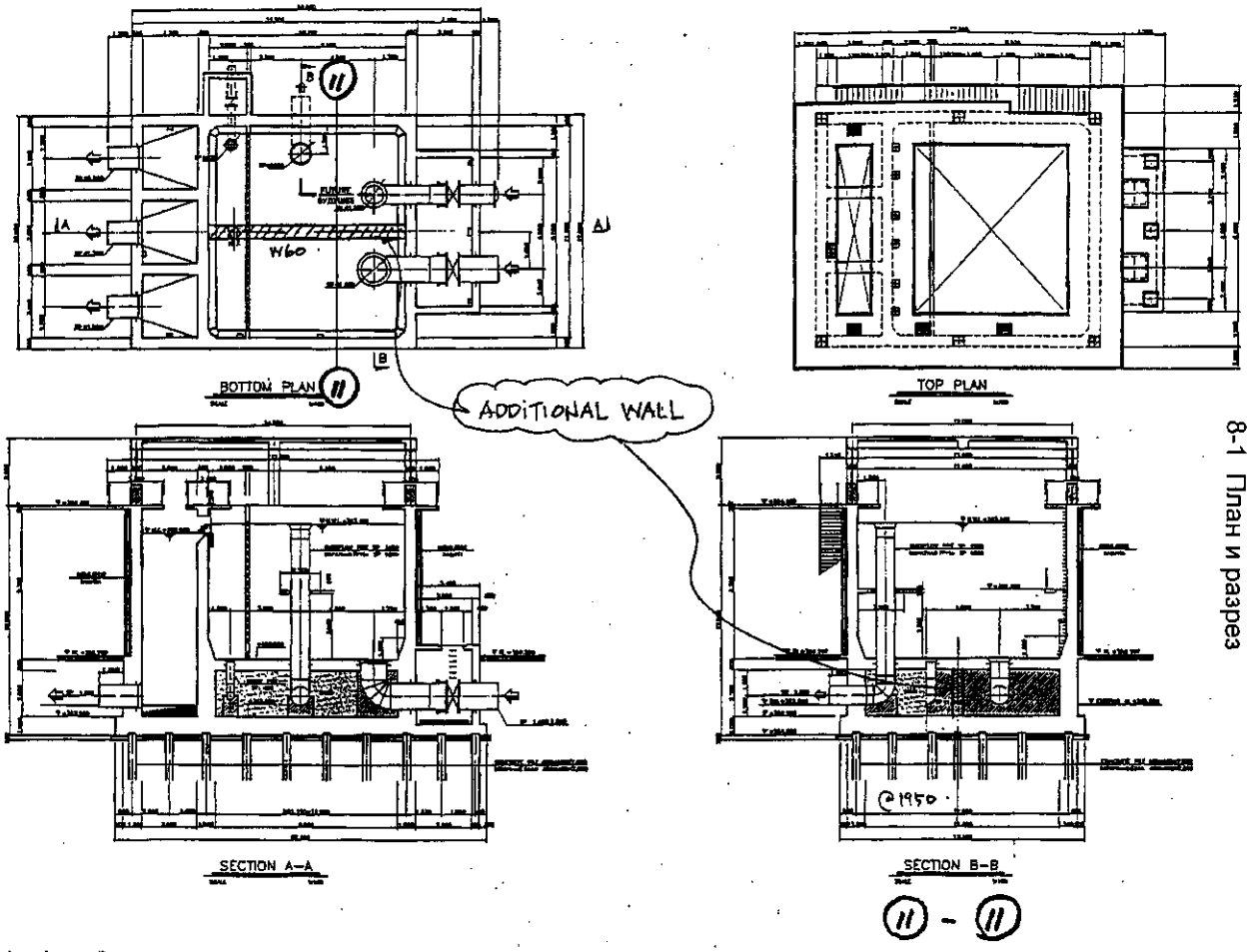
Wmax(T)= Smax(T)·(α/2)·T1 = 0.13 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.03 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

8. DISTRIBUTION CHAMBER

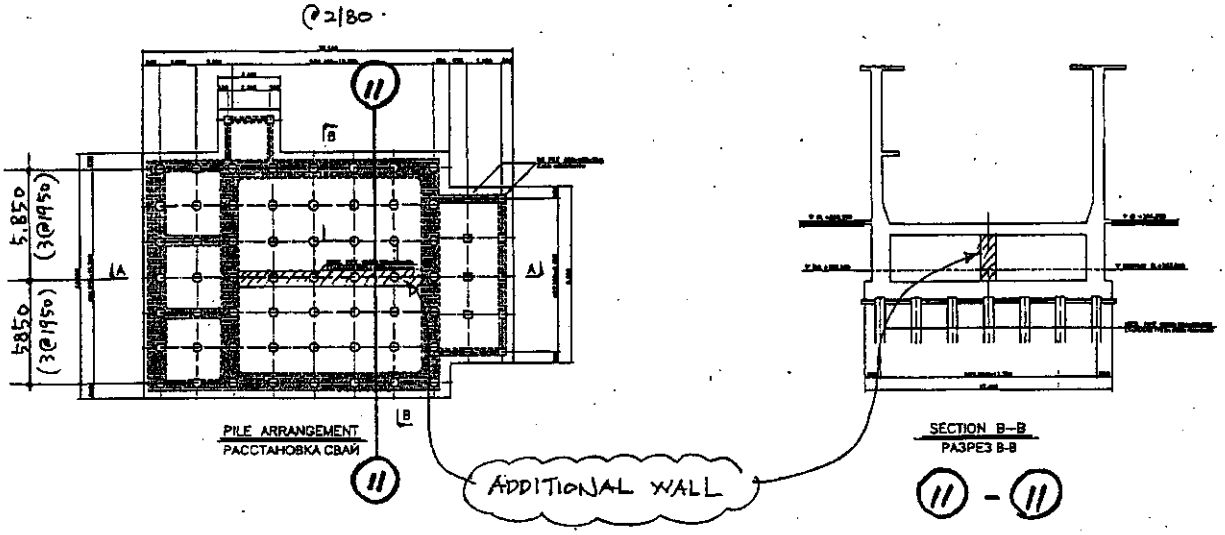
8. РАСПРЕДЕЛИТЕЛЬНАЯ КАМЕРА



8-1 Plan and Section

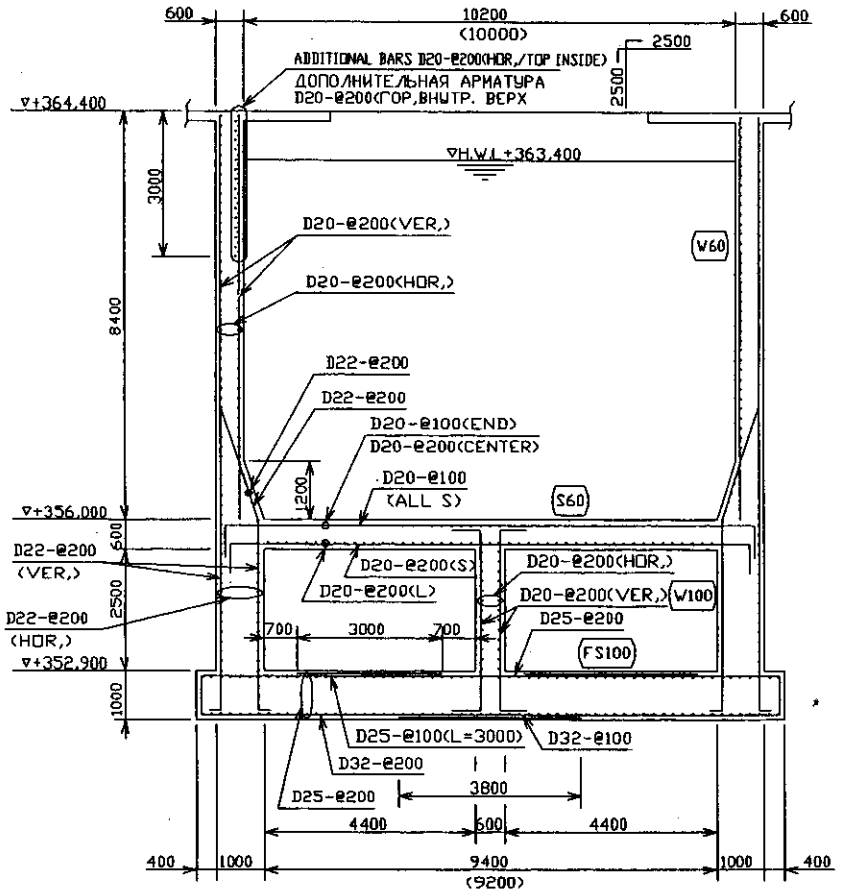
8-1 План и разрез

8-2



8-3

8.2 DESIGN OF WALL & FOOTING
8.2 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ



⑪ – ⑪
S=1/100

LEGEND

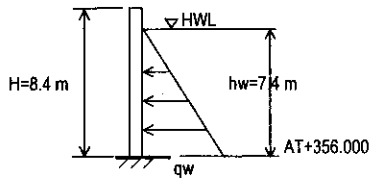
S : SHORT DIRECTION
L : LONG DIRECTION

S : КОРОТКОЕ НАПРАВЛЕНИЕ
L : ДЛИННОЕ НАПРАВЛЕНИЕ

A.7-50

8.2.1 CALCULATION OF WALL (W100~60) ⑪-⑪
(AT+356.000)

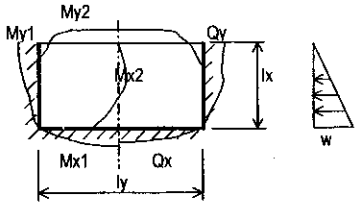
1) DESIGN LOAD (Water Pressure)



hw = 7.40 m
γw = 10.0 KN/m3

qw = γw · hw = 74.0 KN/m2/m

2) FACTORED STRESS (W60)



lx = 7.40 m
ly = 10.20 m
λ = 1.38
w=qw = 74.0 KN/m2/m
Factored Load
w'=1.4 · w = 103.60 KN/m2/m

w' · lx^2 = 5673.1
w' · lx = 766.6

SEE Fig.1

Mx1 =	0.052 x	5673.1 =	295.0	(KN · m/m)
Mx2 =	0.012 x	5673.1 =	68.1	
My1 =	0.033 x	5673.1 =	187.2	
My2 =	0.018 x	5673.1 =	102.1	
Qx =	0.39 x	766.6 =	299.0	(KN/m)
Qy =	0.12 x	766.6 =	92.0	

2) DESIGN OF SECTION

a) VERTICAL : BOT (AT+355.800)

Mu = 295.0 KN·m
Vu = 299.0 KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 940 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.011 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 928
Z2 = 0.95 · d = 893
Z = 893
As 1 = Mu /0.95·fy · Z = 953 mm2
Asmin = 0.0013 · b · D = 1300 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.32 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.20 < 3.0
400/d = 0.4 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.39 N/mm2 > V = 0.32 N/mm2 OK

b) HORIZONTAL : TOP/END

Mu = 187.2 KN·m
Vu = 92.0 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2) = 0.023 < 0.156
Z1 = d · [0.5 + √(0.25−K/0.9)] = 506
Z2 = 0.95 · d = 494
Z = 494
As 1 = Mu /0.95·fy · Z = 1093 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2) (Hor./End)
D 20 @ 200 (Hor./Cent.)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.18 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.60 < 3.0
400/d = 0.8 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.57 N/mm2 > V = 0.18 N/mm2 OK

A.7-51

4) CHECK OF CRACKING ⑪-⑪
W100～60 (VERTICAL:BOT.)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 1000 mm
dv = 940 mm
dh = 920 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ· b· d1 = 875 mm2
As (her.) = ρ· b· d1 = 875 mm2

USE ; VERTICAL D 22 @ 200 (As = 1900 mm2)
USE ; HORIZONTAL D 22 @ 200 (As = 1900 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 295.0 KN·m M = 210.7 KN·m b = 1000 mm
Hor. Mu = KN·m M = KN·m D = 1000 mm
dv = 940 mm
dh = 920 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu·b·dv^2) = 0.0079
Z1 = dv · [0.5 + √(0.25−K/0.9)] = 932
Z2 = 0.95·dv = 893
Z = 893
As = M / fy · Z = 1815 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

HORIZONTAL

K = M / (fcu·b·dh^2) = 0
Z1 = dh · [0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95·dh = 0
Z = 0
As = M / fy · Z = 0 mm2

USE ; D 22 @ 200 (As = 1900 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)·(φ/2ρ(V)) = 969.74 mm
Smax(H) = (fct/fb)·(φ/2ρ(H)) = 969.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b·d1 = 0.0076
ρ(H) = As/b·d1 = 0.0076

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)·(α/2)·T1 = 0.19 < 0.2 mm
Wmax(H)= Smax(H)·(α/2)·T1 = 0.19 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 40 from TABLE 4.2

W60 (VERTICAL:TOP/HORIZONTAL:END) ⑪-⑪

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 250 mm
D = 600 mm
dv = 540 mm
dh = 520 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 875 mm2
As (her.) = ρ・b・d1 = 875 mm2

USE ; VERTICAL D 20 @ 200 (As = 1570 mm2)
USE ; HORIZONTAL D 20 @ 100 (As = 3140 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 68.1 KN・m M = 48.6 KN・m b = 1000 mm
Hor. Mu = 187.2 KN・m M = 133.7 KN・m D = 600 mm
dv = 540 mm
dh = 520 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0056
Z1 = dv・[0.5 + √(0.25—K/0.9)] = 537
Z2 = 0.95・dv = 513
Z = 513
As = M / fy・Z = 728.74 mm2

USE ; D 20 @ 200 (As = 1570 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0.0165
Z1 = dh・[0.5 + √(0.25—K/0.9)] = 510
Z2 = 0.95・dh = 494
Z = 494
As = M / fy・Z = 2081.9 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = {fct/fb}・(φ/2ρ(V)) = 1063.5 mm
Smax(H) = {fct/fb}・(φ/2ρ(H)) = 531.7 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0063
ρ(H) = As/b・d1 = 0.0126

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

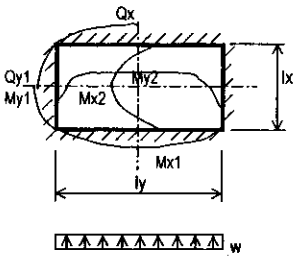
Wmax(V)= Smax(V)・(α/2)・T1 = 0.19 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.09 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 35 from TABLE 4.2

8.2.2 CALCULATION OF SLAB (S60) ⑪-⑪
(AT+356.000)

1) DESIGN LOAD & FACTORED STRESS



hw = 7.40 m
t = 0.60 m
γw = 10.0 KN/m3
γc = 24.0 KN/m4
w=γw・hw+γc・t = 88.4 KN/m2/m

lx = 4.40 m
ly = 9.20 m
λ = 2.09

w = 88.4 KN/m2/m
w'=1.4・w = 123.76 KN/m2/m

w'・lx^2 = 2396.0
w'・lx = 544.5

SEE Fig 2

Mx1 = 0.083 x 2396.0 = 198.9 (KN・m/m)
Mx2 = 0.040 x 2396.0 = 95.8
My1 = 0.057 x 2396.0 = 136.6
My2 = 0.028 x 2396.0 = 67.1

Qx = 0.52 x 544.5 = 283.2 (KN/m)
Qy = 0.46 x 544.5 = 250.5

3) DESIGN OF SECTION (AT+356.000)

a) X-DIRECTION

Mu = 198.9 KN·m (95.8)
Vu = 283.2 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 540 mm

[REQUIRED RE-BAR]

K = Mu /(fcu · b · d^2) = 0.023 < 0.156
Z1 = d · [0.5 + √{ 0.25−K/0.9)} = 526
Z2 = 0.95 · d = 513
Z = 513
As 1 = Mu /0.95 · fy · Z = 1118 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2) (Top)
D 20 @ 200 (Bottom)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.52 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.58 < 3.0
400/d = 0.7 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.56 N/mm2 > V = 0.52 N/mm2 OK

b) Y-DIRECTION

Mu = 136.6 KN·m (67.1)
Vu = 250.5 KN/m

b = 1000 mm fy = 365 N/mm2
D = 600 mm fcu = 30 N/mm2
d = 520 mm

[REQUIRED RE-BAR]

K = Mu /(fcu · b · d^2) = 0.017 < 0.156
Z1 = d · [0.5 + √{ 0.25−K/0.9)] = 510
Z2 = 0.95 · d = 494
Z = 494
As 1 = Mu /0.95 · fy · Z = 797 mm2
Asmin = 0.0013 · b · D = 780 mm2

USE ; D 20 @ 100 (As = 3140 mm2) (Top/End)
D 20 @ 200 (Bot./All)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d) = 0.48 < 4.4 N/mm2 OK
(100 · As)/(b · d) = 0.60 < 3.0
400/d = 0.8 < 1.0 → 1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.57 N/mm2 > V = 0.48 N/mm2 OK

3) CHECK OF CRACKING ⑪-⑪
SLAB (S60)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 600 mm d(B) = 100 mm
d = 540 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ· b· d(T) = 875 mm2
As (bot) = ρ· b· d(B) = 350 mm2

USE ; TOP D 20 @100 (As = 3140 mm2)
USE ; BOTTOM D 20 @200 (As = 1570 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top Mu = 198.9 KN·m M = 142.1 KN·m b = 1000 mm
Bott. Mu = 95.8 KN·m M = 68.4 KN·m D = 600 mm
d = 540 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0.0162
Z1 = d · [0.5 + √{ 0.25−K/0.9)] = 530
Z2 = 0.95·d = 513
Z = 513
As = M / fy · Z = 2130.8 mm2

USE ; D 20 @100 (As = 3140 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.0078
Z1 = d · [0.5 + √{ 0.25−K/0.9)} = 535
Z2 = 0.95·d = 513
Z = 513
As = M / fy · Z = 1025.6 mm2

USE ; D 20 @200 (As = 1570 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 531.75 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 426.8 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0126
ρ(B) = As/b·d(B) = 0.0157

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)·(α/2)·T1 = 0.07 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.05 < 0.2 mm

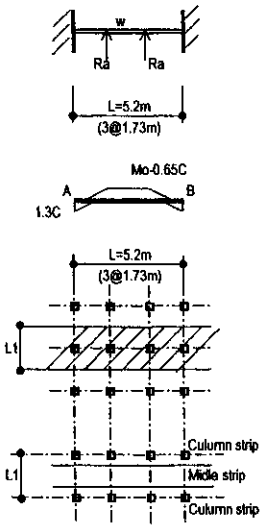
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

8.2.3 CALCULATION OF FOOTING SLAB (FS100) ⑪-⑪

(AT+354.600)

1) DESIGN LOAD & FACTORED STRESS



- Design load

Sand :	Ds	=	2.5	m
	w1 =17.0 · Ds · L1	=	72.3	KN/m
F.Slab :	Df	=	1.0	m
	w =24.0 · D · L1	=	40.8	KN/m
· Factored Load	w' = 1.4 · (w1+w2)	=	158.3	KN/m
· Pile Reaction	Ra	=	750	KN/pile
	Ra' = 1.4 · Ra	=	1050	KN/pile

- Factored stress

	L	=	5.2	m
	C=(2/9 · Ra' · L)-(1/12 · w' · L^2)	=	856.7	KN · m
	Mo=(1/3 · Ra' · L)-(1/8 · w' · L^2)	=	1285.0	KN · m
	M_A = 1.3 · C	=	1113.7	KN · m
	Mo-0.65C	=	728.2	KN · m
	Vu = Ra' - 1/2 · w' · L	=	638.5	KN

- Culumn strip

	L1	=	1.70	m
BOT:	Mu1=0.375 · (1.3 · C)/(1/4 · L1)	=	982.7	KN · m
TOP:	Mu2=0.375 · (Mo-0.65 · C)/(1/4 · L1)	=	642.5	KN · m

2) DESIGN OF SECTION

a) HORIZONTAL : BOT/END

Mu = 982.7 KN·m
Vu = 638.5 KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 940 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2)	=	0.037	< 0.156
Z1 = d · [0.5 + √(0.25 − K/0.9)]	=	900	
Z2 = 0.95 · d	=	893	
Z =		893	
As 1 = Mu /0.95·fy · Z	=	3174	mm2
Asmin = 0.0013 · b · D	=	1300	mm2

USE ; D 32 @ 100 (As = 8040 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d)	=	0.68	<	4.4 N/mm2	OK
(100 · As)/(b · d)	=	0.86	<	3.0	
400/d	=	0.4	<	1.0 →	1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.64 N/mm2 < V = 0.68 N/mm2 NG

b) HORIZONTAL : TOP/CENT

Mu = 642.5 KN·m
Vu = KN/m

b = 1000 mm fy = 365 N/mm2
D = 1000 mm fcu = 30 N/mm2
d = 920 mm

[REQUIRED RE-BAR]

K = Mu / (fcu · b · d^2)	=	0.025	< 0.156
Z1 = d · [0.5 + √(0.25 − K/0.9)]	=	893	
Z2 = 0.95 · d	=	874	
Z =		874	
As 1 = Mu /0.95·fy · Z	=	2120	mm2
Asmin = 0.0013 · b · D	=	1300	mm2

USE ; D 25 @ 100 (As = 4910 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b · d)	=	0.00	<	4.4 N/mm2	OK
(100 · As)/(b · d)	=	0.53	<	3.0	
400/d	=	0.4	<	1.0 →	1.0

Vc = 0.79 · {(100 · As)/(b · d)}^1/3 · (400/d)^1/4 · (1/1.25) · (fcu/25)^1/3
= 0.54 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING ⑪-⑪
FOOTING SLAB (FS100)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 250 mm
D = 1000 mm d(B) = 100 mm
d = 840 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ・b・d(T) = 875 mm2
As (bot) = ρ・b・d(B) = 350 mm2

USE ; TOP D 25 @ 100 (As = 4910 mm2)
USE ; BOTTOM D 32 @ 100 (As = 8040 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES
(BASED ON 3.2.2 OF BS8007)

Top Mu = 642.5 KN・m M = 458.9 KN・m b = 1000 mm
Bott. Mu = 982.7 KN・m M = 701.9 KN・m D = 900 mm
d = 840 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu・b・d^2) = 0.0217
Z1 = d・[0.5 + √(0.25−K/0.9)] = 819
Z2 = 0.95・d = 798
Z = 798
As = M / fy・Z = 4423.6 mm2

USE ; D 25 @ 100 (As = 4910 mm2)

BOTTOM

K = M / (fcu・b・d^2) = 0.0332
Z1 = d・[0.5 + √(0.25−K/0.9)] = 808
Z2 = 0.95・d = 798
Z = 798
As = M / fy・Z = 6766 mm2

USE ; D 32 @ 100 (As = 8040 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)・(φ/2ρ(T)) = 427.3 mm
Smax(B) = (fct/fb)・(φ/2ρ(B)) = 133.3 mm

Where ; fct/fb = 0.67 ρ(T) = As/b・d(T) = 0.0196
ρ(B) = As/b・d(B) = 0.0804

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)・(α/2)・T1 = 0.05 < 0.2 mm
Wmax(B)= Smax(B)・(α/2)・T1 = 0.02 < 0.2 mm

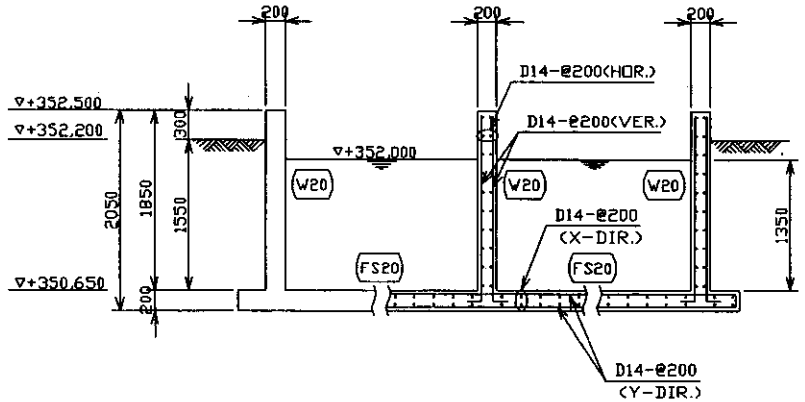
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 25 from TABLE 4.2

9. SLUDGE DRYING BED

9. ИЛОВАЯ ПЛОЩАДКА

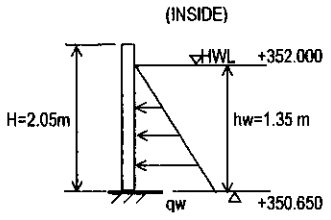
9.1 DESIGN OF WALL & FOOTING
9.1 ПРОЕКТИРОВАНИЕ СТЕНЫ И ОСНОВАНИЯ



⑫ – ⑫
S=1/50

9.2.1 CALCULATION OF WALL (W20) ⑫-⑫
(AT+350.650)

1) DESIGN LOAD & FACTORED STRESS(Water Pressure)



H= 4.6 m
hw= 1.35 m
γw= 10.0 KN/m3

・Design load
qw =γw・hw = 10.0 x 1.35 = 13.5 (KN/m2/m)

・Factored Load
w' =1.4・qw = 1.4 x 13.5 = 18.90 (KN/m2/m)

・Factered stress at +350.650

Mu = 1/6・w'・hw^2 = 5.7 (KN・m/m)
Vu = 1/2・w'・hw = 12.8 (KN/m)

2) DESIGN OF SECTION (INSIDE/VERTICAL BOT.)

Mu = 5.7 KN・m
Vu = 12.8 KN/m

b = 1000 mm fy = 365 N/mm2
D = 200 mm fcu = 30 N/mm2
d = 140 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.010 < 0.156
Z1 = d・{0.5 + √(0.25 − K/0.9)} = 138
Z2 = 0.95・d = 133
Z = 133
As1 = Mu /0.95・fy・Z = 124 mm2
Asmin = 0.0013・b・D = 260 mm2

USE ; D 14 @ 200 (As = 770 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.09 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.55 < 3.0
400/d = 2.9 > 1.0 → 2.9

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・{1/1.25}・(fcu/25)^1/3
= 0.72 N/mm2 > V = 0.09 N/mm2 OK

3) CHECK OF CRACKING ⑫-⑫

W20 (INSIDE VERTICAL:BOT)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 100 mm
D = 200 mm
dv = 140 mm
dh = 120 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 350 mm2
As (her.) = ρ・b・d1 = 350 mm2

USE ; VERTICAL D 14 @ 200 (As = 770 mm2)
USE ; HORIZONTAL D 14 @ 200 (As = 770 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 5.7 KN・m M = 4.1 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 200 mm
dv = 140 mm
dh = 120 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL
K = M / (fcu・b・dv^2) = 0.007
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 139
Z2 = 0.95・dv = 133
Z = 133
As = M / fy・Z = 237.13 mm2

USE ; D 14 @ 200 (As = 770 mm2)

HORIZONTAL
K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 14 @ 200 (As = 770 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 609.09 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 609.1 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0077
ρ(H) = As/b・d1 = 0.0077

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.07 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.07 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 23 from TABLE 4.2

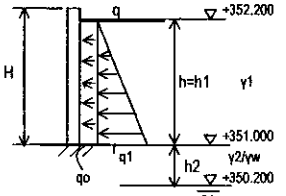
9.2.2 CALCULATION OF WALL (W20) ⑫-⑫
(AT+350.650)

1) DESIGN LOAD & FACTORED STRESS(Soil Pressure)

q : Live Load
Ko: Coefficient of soil pressure at rest

γ1= 18.0 KN/m3 q = 5.0 (KN/m2/m)
γ2= 8.0 KN/m3 Ko = 0.5
γw= 10.0 KN/m3

(OUTSIDE)



Ground Water Level at +350.200

H= 3.8 m
h1= 1.55 m
h2= 0.80 m
h=h1= 1.55 m

・Design load
qo = Ko・q = 2.5 (KN/m2/m)
q1 = Ko・γ1・h1 = 14.0

・Factered Load
w1 = 1.4・qo = 3.5 (KN/m2/m)
w2 = 1.4・q1 = 19.5

・Factered stress at +351.000
Mu1 = 1/2・w1・h^2 = 4.20 (KN・m/m)
Vu1 = w1・h = 5.43 (KN/m)
Mu2 = 1/6・w2・h^2 = 7.82 (KN・m/m)
Vu2 = 1/2・w2・h = 15.14 (KN/m)

Mu = Mu1 + Mu2 = 12.0 (KN・m/m)
Vu = Vu1 + Vu2 = 20.6 (KN/m)

2) DESIGN OF SECTION (OUTSIDE/VERTICAL BOT.)

Mu = 12.0 KN・m
Vu = 20.6 KN/m

b = 1000 mm fy = 365 N/mm2
D = 500 mm fcu = 30 N/mm2
d = 440 mm

[REQUIRED RE-BAR]
K = Mu / (fcu・b・d^2) = 0.002 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 439
Z2 = 0.95・d = 418
Z = 418
As1 = Mu /0.95・fy・Z = 83 mm2
Asmin = 0.0013・b・D = 650 mm2

USE ; D 20 @ 100 (As = 3140 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.05 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.71 < 3.0
400/d = 0.9 < 1.0 → 1.0

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.60 N/mm2 > V = 0.05 N/mm2 OK

3) CHECK OF CRACKING ⑫-⑫

W20 (OUTSIDE VERTICAL:BOT)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d1 = 100 mm
D = 200 mm
dv = 140 mm
dh = 120 mm

Min. ρ = 0.0035 (0.35 %)

As (ver.) = ρ・b・d1 = 350 mm2
As (her.) = ρ・b・d1 = 350 mm2

USE ; VERTICAL D 14 @200 (As = 770 mm2)
USE ; HORIZONTAL D 14 @200 (As = 770 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Ver. Mu = 12.0 KN・m M = 8.6 KN・m b = 1000 mm
Hor. Mu = 0.0 KN・m M = 0.0 KN・m D = 200 mm
dv = 140 mm
dh = 120 mm
fy = 130 N/mm2
fcu = 30 N/mm2

VERTICAL

K = M / (fcu・b・dv^2) = 0.0146
Z1 = dv・[0.5 + √(0.25−K/0.9)] = 138
Z2 = 0.95・dv = 133
Z = 133
As = M / fy・Z = 497.4 mm2

USE ; D 14 @200 (As = 770 mm2)

HORIZONTAL

K = M / (fcu・b・dh^2) = 0
Z1 = dh・[0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95・dh = 0
Z = 0
As = M / fy・Z = 0 mm2

USE ; D 14 @200 (As = 770 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(V) = (fct/fb)・(φ/2ρ(V)) = 609.09 mm
Smax(H) = (fct/fb)・(φ/2ρ(H)) = 609.1 mm

Where ; fct/fb = 0.67 ρ(V) = As/b・d1 = 0.0077
ρ(H) = As/b・d1 = 0.0077

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(V)= Smax(V)・(α/2)・T1 = 0.07 < 0.2 mm
Wmax(H)= Smax(H)・(α/2)・T1 = 0.07 < 0.2 mm

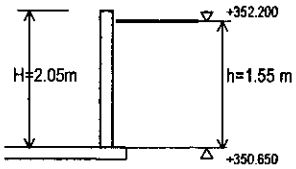
Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 23 from TABLE 4.2

A.7-58

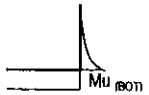
9.2.3 CALCULATION OF FOOTING SLAB (FS20) ⑫-⑫
(AT+350.650)

1) FACTORED STRESS



・Factered stress at +350.650

from Moment of Inside of Wall (refer to para.9.2.1)
Mu (TOP) = 5.7 (KN・m/m)



from Moment of Outside of Wall (refer to para.9.2.2)
Mu (BOT) = 12.0 (KN・m/m)

2) DESIGN OF SECTION (BOTTOM BAR)

Mu = 12.0 KN・m
Vu = KN/m

b = 1000 mm fy = 365 N/mm2
D = 200 mm fcu = 30 N/mm2
d = 140 mm

[REQUIRED RE-BAR]

K = Mu / (fcu・b・d^2) = 0.020 < 0.156
Z1 = d・[0.5 + √(0.25−K/0.9)] = 137
Z2 = 0.95・d = 133
Z = 133
As1 = Mu /0.95・fy・Z = 261 mm2
Asmin = 0.0013・b・D = 260 mm2

USE ; D 14 @ 200 (As = 770 mm2)

[CHECK OF SHEAR STRESS]

V = Vu /(b・d) = 0.00 < 4.4 N/mm2 OK
(100・As)/(b・d) = 0.55 < 3.0
400/d = 2.9 > 1.0 → 2.9

Vc = 0.79・{(100・As)/(b・d)}^1/3・(400/d)^1/4・(1/1.25)・(fcu/25)^1/3
= 0.72 N/mm2 > V = 0.00 N/mm2 OK

3) CHECK OF CRACKING ⑫-⑫ 9-8

FOOTING SLAB (FS20)

a) CHECK OF MINIMUM REINFORCEMENT (BASED ON 2.6.2.3 OF BS8007)

SECTION b = 1000 mm SURFACE ZONE : d(T) = 100 mm
D = 200 mm d(B) = 100 mm
d = 140 mm

Min. ρ = 0.0035 (0.35 %)

As (top) = ρ · b · d(T) = 350 mm2
As (bot) = ρ · b · d(B) = 350 mm2

USE ; TOP D 14 @200 (As = 770 mm2)
USE ; BOTTOM D 14 @200 (As = 770 mm2)

b) CHECK OF STEEL STRESS IN DIRECT OR FLEXURAL TENSION FOR SERVICEBILITY LIMIT STATES (BASED ON 3.2.2 OF BS8007)

Top Mu = KN·m M = 0.0 KN·m b = 1000 mm
Bott. Mu = 12.0 KN·m M = 8.6 KN·m D = 200 mm
d = 140 mm
fy = 130 N/mm2
fcu = 30 N/mm2

TOP

K = M / (fcu·b·d^2) = 0
Z1 = d · [0.5 + √(0.25−K/0.9)] = 0
Z2 = 0.95·d = 0
Z = 0
As = M / fy · Z = 0 mm2

USE ; D 14 @200 (As = 770 mm2)

BOTTOM

K = M / (fcu·b·d^2) = 0.0146
Z1 = d · [0.5 + √(0.25−K/0.9)] = 138
Z2 = 0.95·d = 133
Z = 133
As = M / fy · Z = 497.4 mm2

USE ; D 14 @200 (As = 770 mm2)

c) CHECK OF CRACK WIDTH (BASE ON APPENDIX A OF BS8007)

1) CRACK SPACING

Smax(T) = (fct/fb)·(φ/2ρ(T)) = 609.09 mm
Smax(B) = (fct/fb)·(φ/2ρ(B)) = 609.1 mm

Where ; fct/fb = 0.67 ρ(T) = As/b·d(T) = 0.0077
ρ(B) = As/b·d(B) = 0.0077

2) CRACK WIDTHS ARISING FORM RESTRAINED SHRINKAGE AND HEAT OF HYDRATION MOVEMENT

Wmax(T)= Smax(T)·(α/2)·T1 = 0.05 < 0.2 mm
Wmax(B)= Smax(B)·(α/2)·T1 = 0.05 < 0.2 mm

Where ; α : COEFFICIENT OF THERMAL EXPANSION OF MATURE CONCRETE

α= 1E-05
T1= 15 from TABLE 4.2

A.7-59

10. ATTACHMENT

10. ПРИЛОЖЕНИЕ

Number of Piles

Calculation of Pile Foundation

Calculation Formula

Ultimate Bearing Capacity $qu = 30 \cdot N \cdot Ap \cdot \eta + U \cdot \Sigma(li \cdot fi)$
Allowable Bearing Capacity Bearing Pile Ordinary $Ra = 1/3 \cdot Ru$
Friction Pile Ordinary $Ra = 1/4 \cdot Ru$

Ap : sectional area of a pile (m2)
η : clogging coefficient (for steel pile)
U : perimeter length of pile (m)
li : pile length (m)
fi : perimeter friction (tf/m)

Facilities	Pile Length	Bearing Strata	Embedment	Mean N value	Pile Cross-sectional Area			Crog. Coef.	Perimeter Length			Cohesive Soil		Thickness	Cohesion	Allow. Bear. Capacity (tf/pile)			Structure Area	Load	Number of Piles				Application
					300	400	500		300	400	500				C	Pile Size (mm)						Pile Size (mm)		
	m		m		m2	m2	m2		m	m	m			m	t/m2	300	400	500	m^2	ton		300	400	500	
Distribution Chamber	3	3rd sand	2	11	0.09	0.16	0.25	1	1.2	1.6	2	①	3rd	2	0						nmbr	412	218	138	
												②		0	0	9	17	27	190	3,700	area	0.46	0.87	1.38	
												③		0	0						intrvl	0.67	0.93	1.17	
	7	5th sandy-clay	3	9	0.09	0.16	0.25	1	1.2	1.6	2	①	5th	3	7.1						nmbr	232	148	103	
												②		0	0	16	25	36	190	3,700	area	0.82	1.28	1.84	
												③		0	0						intrvl	0.90	1.13	1.35	
	11.5	6th clay	1	8	0.09	0.16	0.25	1	1.2	1.6	2	①	5th	5	7.1						nmbr	161	109	79	500
												②	6th	1	5.8	23	34	47	190	3,700	area	1.18	1.74	2.41	11.5m
												③		0	0						intrvl	1.08	1.32	1.55	90 piles
Receiving Well	1.5	1st sandy-silt	-	4	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	1.5	4.3						nmbr	491	327	211	
												②		0	0	6	9	14	143	2,942	area	0.29	0.44	0.68	
												③		0	0						intrvl	0.53	0.66	0.82	
	6	5th sandy-clay	1	9	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	3	4.3						nmbr	184	118	85	
												②	5th	1	7.1	16	25	35	143	2,942	area	0.76	1.21	1.68	
												③		0	0						intrvl	0.88	1.10	1.29	
	12	6th clay	1	8	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	3	4.3						nmbr	109	76	56	500
												②	5th	4.5	7.1	27	39	53	143	2,942	area	1.31	1.88	2.55	12m
												③	6th	1	5.8						intrvl	1.14	1.37	1.59	56 piles
Flocculation and Sedimentation Basin	2	1st sandy-silt	-	4	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	2	4.3						nmbr	6,088	4,261	2,841	
												②		0	0	7	10	15	4,124	42,610	area	0.68	0.97	1.45	
												③		0	0						intrvl	0.82	0.98	1.20	
	8 -12.5	5th sandy-clay	2.5	9	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	2	4.3						nmbr	2,368	1,522	1,066	400
												②	5th	2.5	7.1	18	28	40	4,124	42,610	area	1.74	2.71	3.87	8-12.5m
												③		0	0						intrvl	1.31	1.64	1.96	1554 piles
	12 -16.5	6th clay	1	8	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	2	4.3						nmbr	1,776	1,218	888	
												②	5th	4	7.1	24	35	48	4,124	42,610	area	2.32	3.39	4.64	
												③	8th	1	5.8						intrvl	1.52	1.84	2.15	
Rapid Sand Filter	4	1st sandy-silt	2	4	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	2	4.3						nmbr	3,843	2,690	1,794	
												②		0	0	7	10	15	2,564	26,900	area	0.67	0.95	1.43	
												③		0	0						intrvl	0.81	0.97	1.19	
	9.5 -11	5th sandy-clay	2	9	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	3	4.3						nmbr	1,495	961	673	400
												②	5th	2	7.1	18	28	40	2,564	26,900	area	1.72	2.67	3.81	9.5-11m
												③		0	0						intrvl	1.30	1.63	1.95	1026 piles
	12.5	6th clay	1	8	0.09	0.16	0.25	1	1.2	1.6	2	①	1st	3	4.3						nmbr	1,281	841	612	
												②	5th	2.5	7.1	21	32	44	2,564	26,900	area	2.00	3.05	4.19	
												③	6th	1	5.8						intrvl	1.41	1.74	2.04	

10-2

10-3

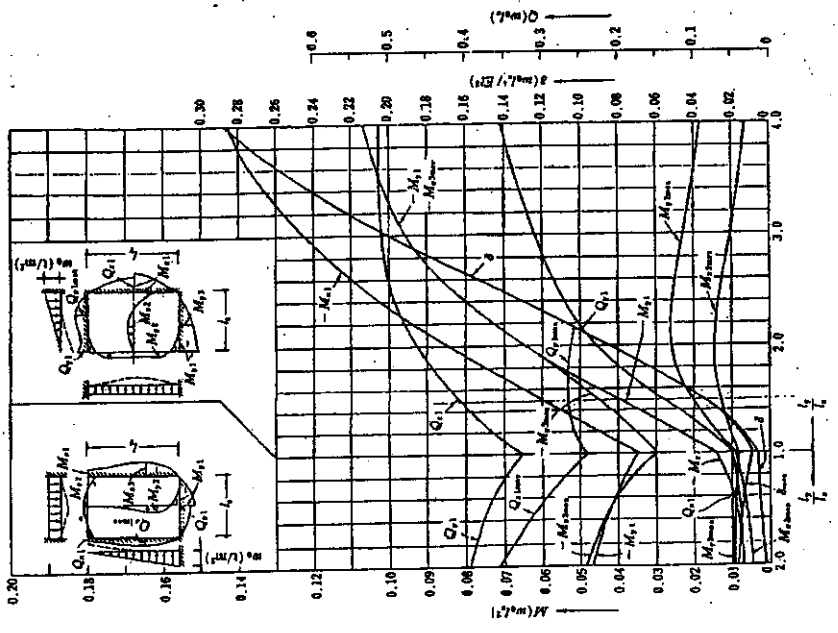


Рис. 1:
3 стороны закреплены, другая свободна (вследствие равномерно изменяемых нагрузок)

Fig. 1:
3 sides are fixed and the other is free (due to uniformly varied load)

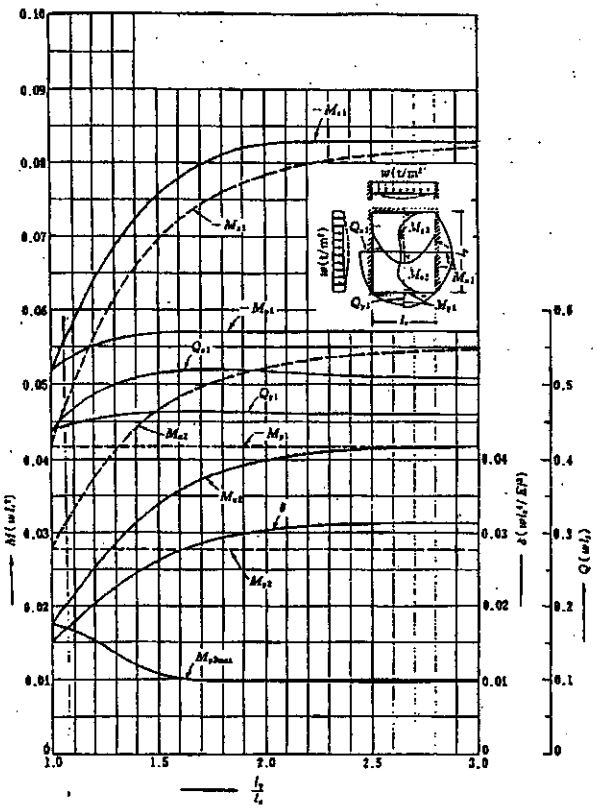


Fig. 2: 4 sides are fixed (due to uniform load)	Рис. 2: 4 стороны закреплены (вследствие равномерных нагрузок)