COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

INQUIRING No. | INQUIRED BY | SHEET No. 27
JOB NAME | ADDRESS | DATE ORIGINAL
SPACE USED FOR JUNIOR ENGINEER ROOM (TO 1 d) PAC - 1 SYSTEM | REVISION
SIZE 10.5 m × 6.5 m = 68.25 m² × m H = 225.55 m³ | PERSON IN CHARGE

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h	Correction	
SOLAR GAIN — GLASS				MAX 6:00	3:00	5:00
(NW)	6.9 m² ×	366 × 0.64/0.85 ×	0.94 × 0.65	1162	618	1180
	m² ×	×				
	m² ×	×				
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (NW)	19.1 m² ×	23.2 ×	2.1	931	258	783
	m² ×	×				
	m² ×	×				
	m² ×	×				
ROOF—SUN	42.25 m² ×	28.5 ×	1.7	2047	1724	1997
ROOF—~~SHADED~~	26.0 m² ×	28.5 ×	1.1	816	687	795
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	6.9 m² ×	14.7 ×	5.1	518	641	581
CEILING	m² ×	×				
FLOOR	10.0 m² ×	7.35 ×	1.7	125	155	141
PARTITION	m² ×	×				
INFILTRATION	CMH ×	deg ×	0.29			
INTERNAL HEAT						
PEOPLE	6 PEOPLE × 41			246	246	246
KW	KW ×	×	860			
LIGHTS	68.25 × 20 W ×		1.08	1475	1475	1475
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m² ×	deg ×		(−)	(−)	
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM SENSIBLE HEAT SUB TOTAL				7320	5804	7198
SUPPLY DUCT HEAT GAIN + SUPPLY DUCT LEAK LOSS + FAN HP			= 10%	732	581	720
BYPASS OUTSIDE AIR	150 CMH ×	14.7 deg × 0.1 B.F × 0.29		64	80	72
EFFECTIVE ROOM SENSIBLE HEAT				8116	6465	7990
ROOM LATENT HEAT						
INFILTRATION	CMH ×	g/kg ×	0.72			
PEOPLE	6 PEOPLE × 49			294	294	294
STEAM		kg/h ×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				294	294	294
SUPPLY DUCT LEAKAGE LOSS			10 %	30	30	30
BYPASS OUTSIDE AIR	150 CMH ×	9.4 g/kg × 0.1 BF × 0.72		102	104	103
EFFECTIVE ROOM LATENT HEAT				426	428	427
EFFECTIVE ROOM TOTAL HEAT				8542	6893	8417
OUTSIDE AIR HEAT						
SENSIBLE:	CMH ×	deg × (1 − BF) × 0.29				
LATENT:	CMH ×	g/kg × (1 − BF) × 0.72				
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN + RETURN DUCT LEAK GAIN + PUMP H.P + PIPE GAIN			= %			
(U.S.R.T) GRAND TOTAL HEAT						

ESTIMATE FOR. AM PM | PEAK LOAD AM PM 6

HOURS OF OPERATION Hour (~)

OUTSIDE DESIGN CONDITIONS CDB CWB %RH

CONDITIONS	DB ℃	WB ℃	%RH	DP ℃	g/kg
OUTSIDE	38.7	27.6	43		18.8
ROOM	24.0	17.1	50		9.4
DIFFERENCE	14.7	×××	×××	×××	9.4

BLIND: NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS: ORDINARY, THICK, ABSORBENT. %, DOUBLE
COLOR: LIGHT, MEDIUM, DARK.
WEIGHT: kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT: W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE × CMH/PER.	
OPEN DOORS DOORS × CMH/DOOR	
EXHAUST AIR	
CRACK m × CMH/m	
INFILTRATION CMH	

VENTILATION

6 PEOPLE × 25 CMH/PER.	150
m² × CMH/m²	
VENTILATION CMH	150

SENSIBLE HEAT FACTOR

E.S.H.F = 8116 (ERSH) / 8542 (ERTH) = 0.95 (12.6℃)

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 ℃

8116 (ERSH) / (24 RM − 12.5 ADP)(1 − 0.1 BF) × 0.29 = 2710 CMH

NOTES
. GLASS (NW) : 1.5 × 1.8 + 1.5 × 2.8 = 6.9
. WALL (NW) : 6.5 × 4.0 − 6.9 = 19.1
. FLOOR : 4.0 × 2.5 = 10.0
. ROOF (1) : 4.0 × 6.5 = 26.0
(2) : 6.5 × 6.5 = 42.25

FORM E-205

1024

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

INQUIRING No.	INQUIRED BY
JOB NAME	ADDRESS
SPACE USED FOR JUNIOR ENGINEER ROOM (TO I C)	PAC- I SYSTEM
SIZE 10.5 m × 6.5 m = 68.25 m² × m(H) = 225.55 m³	

SHEET No.	28
DATE ORIGINAL	
REVISION	
PERSON IN CHARGE	

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h	CORRECTION	
SOLAR GAIN — GLASS				MAX 6:00	3:00	5:00
(NW)	6.9 m² ×	366 × 0.64/0.85 ×	0.94 × 0.65	1162	618	1180
	m² ×	×				
	m² ×	×				
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (NW)	19.1 m² ×	23.2 ×	2.1	931	258	783
	m² ×	×				
	m² ×	×				
	m² ×	×				
ROOF—SUN	42.25 m² ×	28.5 ×	1.7	2047	1724	1997
ROOF—~~SHADED~~	26.0 m² ×	28.5 ×	1.1	816	687	795
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	6.9 m² ×	14.7 ×	5.1	518	641	581
CEILING	m² ×	×				
FLOOR	m² ×	×				
PARTITION	m² ×	×				
INFILTRATION	CMH ×	deg ×	0.29			
INTERNAL HEAT						
PEOPLE	6 PEOPLE × 41			246	246	246
Kw	Kw ×	×	860			
LIGHTS	68.25 × 20 W ×		1.08	1475	1475	1475
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m² ×	deg ×		(−)	(−)	
			Sub TOTAL			
SAFETY FACTOR			%			
ROOM SENSIBLE HEAT Sub TOTAL				7195	5649	7057
SUPPLY DUCT HEAT GAIN	SUPPLY DUCT +LEAK LOSS	FAN +HP	10 %	720	565	706
BYPASS OUTSIDE AIR	6 CMH × 14.7 deg × 0.1 BF × 0.29			64	80	72
EFFECTIVE ROOM SENSIBLE HEAT ■				7979	6294	7835
ROOM LATENT HEAT						
INFILTRATION	CMH ×	g/kg ×	0.72			
PEOPLE	6 PEOPLE × 49					
STEAM		kg/h ×	540	294		
APPLIANCES ETC.						
VAPOR TRANS.						
			Sub TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT Sub TOTAL				294	294	294
SUPPLY DUCT LEAKAGE LOSS			10 %	30	30	30
BYPASS OUTSIDE AIR	150 CMH × 9.4 g/kg × 0.1 BF × 0.72			102	104	103
EFFECTIVE ROOM LATENT HEAT ■				426	428	427
EFFECTIVE ROOM TOTAL HEAT ▣				8405	6722	8262
OUTSIDE AIR HEAT				(124)		
SENSIBLE:	CMH ×	deg × (1 − BF) × 0.29				
LATENT:	CMH ×	g/kg × (1 − BF) × 0.72				
GRAND TOTAL HEAT Sub TOTAL						
RETURN DUCT HEAT GAIN + RETURN DUCT LEAK GAIN + PUMP H.P + PIPE GAIN = %						
(U.S.R.T) GRAND TOTAL HEAT ▣						

ESTIMATE FOR	AM PM	PEAK LOAD	AM PM 6	
HOURS OF OPERATION	Hour (~)			

OUTSIDE DESIGN CONDITIONS °CDB °CWB %RH

CONDITIONS	DB ℃	WB ℃	%RH	DP ℃	g/kg
OUTSIDE	38.7	27.6	43		18.8
ROOM	24.0	17.1	50		9.4
DIFFERENCE	14.7	×××	×××	×××	9.4

BLIND	NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D.
GLASS	ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR	LIGHT. MEDIUM. DARK.
WEIGHT	kg/m² (FLOOR) kg/m² (WALL)
INTERNAL HEAT	W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE × CMH/PER.	
OPEN DOORS DOORS × CMH/DOOR	
EXHAUST AIR	
CRACK m × CMH/m.	
INFILTRATION CMH ■	

VENTILATION

6 PEOPLE × 25 CMH/PER.	150
m² × CMH/m²	
VENTILATION CMH ■	150

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{7979 \text{ (ERSH)}}{8405 \text{ (ERTH)}} = 0.95 \ (12.6°C)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 ℃

$$\frac{\text{(ERSH)}}{(24 \text{ RM} - 12.5 \text{ ADP})(1 - 0.1 \text{ BF}) \times 0.29} = 2.670 \text{ CMH}$$

NOTES

$VR = 4.0 \times 6.5 \times 2.5 + 6.5 \times 6.5 \times 3.8$

$= 225.55$

GLASS (NW) : $1.5 \times 1.8 + 1.5 \times 2.8 = 6.9$

WALL (NW) : $6.5 \times 4.0 - 6.9 = 19.1$

ROOF (1) : $4.0 \times 6.5 = 26.0$

(2) : $6.5 \times 6.5 = 42.25$

1025

FORM E-20E

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

Inquiring No.	Inquired By
Job Name	Address
Space Used For JUNIOR ENGINEER ROOM (T01b)	PAC-1 SYSTEM
Size 10.5 m× 6.5 m= 68.25 m² × ~~2.5~~ 3.8 m(H)= 225.55 m³	

Sheet No. 29
DATE ORIGINAL
REVISION
PERSON IN CHARGE

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h	Correction	
SOLAR GAIN — GLASS				MAX 6:00	3:00	5:00
(NW)	6.9 m²×	366 ×0.64/85	× 0.94 × 0.65	1162	618	1180
	m²×		×			
	m²×		×			
	m²×		×			
	m²×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (NW)	19.1 m²×	23.2	× 2.1	931	258	783
	m²×		×			
	m²×		×			
	m²×		×			
Roof—Sun	42.25 m²×	28.5	× 1.7	2047	1724	1997
Roof—~~Shaded~~	26.0 m²×	28.5	× 1.1	816	687	795
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	6.9 m²×	14.7	× 5.1	518	641	581
Ceiling	m²×		×			
Floor	m²×		×			
Partition	10.0 m²×	7.35	× 1.8	133	164	149
Infiltration	CMH×	deg×	0.29			
INTERNAL HEAT						
People	6 People×	41		246	246	246
Kw	Kw×	×	860			
Lights	68.25 × 20 W×		1.08	1475	1475	1475
Appliances Etc.						
Credit for Thermal Storage	m²×	deg×		(–)	(–)	
			Sub Total			
Safety Factor			%			
Room Sensible Heat Sub Total				7328	5813	7206
Supply Duct Heat Gain	+ Supply Duct Leak Loss	+ Fan HP	= 10 %	733	582	721
Bypass outside air	150 CMH×	14.7 deg×	0.1 B.F.×0.29	64	80	72
EFFECTIVE ROOM SENSIBLE HEAT				8125	6475	7999
ROOM LATENT HEAT						
Infiltration	CMH×	g/kg×	0.72			
People	6 People×	49		294		
Steam		kg/h×	540			
Appliances etc.						
Vapor trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total				294	294	294
Supply Duct Leakage Loss			10 %	30	30	30
Bypass Outside Air	150 CMH×	9.4 g/kg×	0.1 BF×0.72	102	104	103
EFFECTIVE ROOM LATENT HEAT				426	428	427
EFFECTIVE ROOM TOTAL HEAT				8551	6903	8426
OUTSIDE AIR HEAT				(126)		
Sensible:	CMH×	deg×(1–	BF)×0.29			
Latent:	CMH×	g/kg×(1–	BF)×0.72			
Grand Total Heat Sub Total						
Return Duct Heat Gain	+ Return Duct Leak Gain	+ Pump H.P	– Pipe Gain = %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For: AM PM. Peak Load AM PM 6

HOURS OF OPERATION Hour (~)

Outside Design Conditions CDB CWB %RH

Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	38.7	27.6	43		18.8
Room	24.0	17.1	50		9.4
Difference	14.7	×××	×××	×××	9.4

BLIND (NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D.
GLASS ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR LIGHT. MEDIUM. DARK.
WEIGHT kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT W·m² m²/PEOPLE

INFILTRATION
Swinging
Revolving Doors People× CMH/PER.
Open Doors Doors× CMH/DOOR
Exhaust Air
Crack m× CMH/m
Infiltration CMH

VENTILATION
6 People× 25 CMH/PER. 150
m²× CMH/m²
Ventilation CMH 150

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{8125\ (ERSH)}{8551\ (ERTH)} = 0.95\ (12.6°C)$$

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

$$\frac{8125\ (ERSH)}{(24RM - 12.5ADP)(1 - 0.1BF)\times 0.29} = 2710\ CMH$$

NOTES
GLASS (NW): 1.5×1.8 + 1.5×2.8 = 6.9
WALL (NW): 6.5×4.0 − 6.9 = 19.1
ROOF (1): 4.0×6.5 = 26.0
(2): 6.5×6.5 = 42.25
PARTITION: 4.0×2.5 = 10.0
VR = 4.0×6.5×2.5 + 6.5×6.5×3.8 = 225.55

FORM E-20E

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

INQUIRING No	INQUIRED BY
JOB NAME	ADDRESS
SPACE USED FOR JONIOR ENGINEER ROOM (To 1 a) PAC-1 SYSTEM	
SIZE m× m= 60.25 m² × 2.5, 3.8 m(H)= 205.55 m³	

SHEET No.	30
DATE ORIGINAL	
REVISION	
PERSON IN CHARGE	

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h	CORRECTION	
SOLAR GAIN — GLASS				MAX 5:00	3:00	6:00
(NW)	6.9 m²×	366 × 0.65/0.85	× 0.94×0.65	1180	618	1162
(SW)	8.1 m²×	252 × 0.5/0.85	× 0.94×1.65	734	1028	382
	m²×		×			
	m²×		×			
	m²×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (NW)	19.1 m²×	19.5	× 2.1	783	258	931
(SW)	33.9 m²×	19.2	× 2.1	1367	1125	1389
	m²×		×			
	m²×		×			
ROOF—SUN	42.25 m²×	27.8	× 1.7	1997	1724	2047
ROOF—~~SHADED~~	18.0 m²×	27.8	× 1.1	551	476	565
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	15.0 m²×	16.5	× 5.1	1263	1393	1125
CEILING	m²×		×			
FLOOR	m²×		×			
PARTITION	17.6 m²×	8.25	× 1.8	262	289	233
INFILTRATION	CMH×	deg×	0.29			
INTERNAL HEAT						
PEOPLE	6 PEOPLE×	41		246	246	246
KW	KW×	×	860			
LIGHTS	60.25 × 20 W×		1.08	1475	1475	1475
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m²×	deg×		(–)	(–)	
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM SENSIBLE HEAT SUB TOTAL				9858	8632	9555
SUPPLY DUCT HEAT GAIN	+ SUPPLY DUCT LEAK LOSS	+ FAN HP	= 16%	986	864	956
BYPASS OUTSIDE AIR	150 CMH × 16.5 deg × 0.1 B.F × 0.29			72	80	64
EFFECTIVE ROOM SENSIBLE HEAT ■				10916	9576	10575
ROOM LATENT HEAT						
INFILTRATION	CMH×	g/kg×	0.72			
PEOPLE	6 PEOPLE×	49		294		
STEAM		kg/h×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				294	294	294
SUPPLY DUCT LEAKAGE LOSS			10%	30	30	30
BYPASS OUTSIDE AIR	150 CMH × 9.5 g/kg × 0.1 BF × 0.72			103	104	102
EFFECTIVE ROOM LATENT HEAT ■				427	428	426
EFFECTIVE ROOM TOTAL HEAT ▣				11343	10,004	11001
OUTSIDE AIR HEAT				(189)		
SENSIBLE:	CMH×	deg×(1− BF)×0.29				
LATENT:	CMH×	g/kg×(1− BF)×0.72				
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN	+ RETURN DUCT LEAK GAIN	+ PUMP H.P	+ PIPE GAIN = %			
(U.S.R.T) GRAND TOTAL HEAT ▣						

ESTIMATE FOR	AM PM	PEAK LOAD	AM PM 5	
HOURS OF OPERATION	Hour (~)			
OUTSIDE DESIGN CONDITIONS	°CDB	°CWB	%RH	

CONDITIONS	DB ℃	WB ℃	%RH	DP ℃	g/kg
OUTSIDE	40.5	28.2	39		18.9
ROOM	24.0	17.1	50		9.4
DIFFERENCE	16.5	×××	×××	×××	9.5

BLIND	NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS	ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR	LIGHT. MEDIUM. DARK.
WEIGHT	kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT	W·m² m²/PEOPLE

INFILTRATION	
SWINGING	
REVOLVING DOORS PEOPLE× CMH/PER.	
OPEN DOORS DOORS× CMH/DOOR	
EXHAUST AIR	
CRACK m× CMH/m	
INFILTRATION CMH ■	
VENTILATION	
6 PEOPLE× 25 CMH/PER.	150
m²× CMH/m²	
VENTILATION CMH ■	150

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{10916 \text{ (ERSH)}}{11343 \text{ (ERTH)}} = 0.96 \ (12.6°C)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 ℃

$$\frac{10916 \text{ (ERSH)}}{(24 \text{ RM} - 12.5 \text{ ADP})(1 - 0.1 \text{ BF}) \times 0.29} = 3.640 \text{ CMH}$$

NOTES

SR = 10.5 × 6.5 − 2.0 × 4.0 = 60.25

GLASS (NW): 1.5 × 1.8 + 1.5 × 2.8 = 6.9

(SW): 1.5 × 1.8 × 3 = 8.1

WALL (NW): 6.5 × 4.0 − 6.9 = 19.1

(SW): 10.5 × 4.0 − 8.1 = 33.9

ROOF (1): 4.0 × 4.5 = 18.0

(2): 6.5 × 6.5 = 42.25

PARTITION: 4.0 × 2.5 + 2.0 × 3.8 = 17.6

VR: 4.0 × 4.5 × 2.5 + 6.5 × 6.5 × 3.8

= 205.55

FORM E-20

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

INQUIRING No. | INQUIRED BY | SHEET No 31

JOB NAME | ADDRESS | DATE ORIGINAL

SPACE USED FOR CONFERENCE ROOM (F03) PAC-Z SYSTEM | REVISION

SIZE 13.0 m × 6.5 m = 84.5 m² × 3.0 m(H) = 253.5 m³ | PERSON IN CHARGE

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h MAX 2:00	CORRECTION 3:00	CORRECTION 4:00
SOLAR GAIN — GLASS						
(SE)	12.3 m² ×	252 × 0.29/0.85 ×	0.94 × 0.65	647	535	468
	m² ×	×				
	m² ×	×				
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (SE)	39.7 m² ×	13.9 ×	2.1	1159	1076	777
	m² ×	×				
	m² ×	×				
	m² ×	×				
ROOF—SUN	m² ×	×				
ROOF—SHADED	m² ×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	12.78 m² ×	17.7 ×	5.1	1154	1187	1154
CEILING	m² ×	×				
FLOOR	84.5 m² ×	12.7 ×	2.5	2683	2789	2683
PARTITION (1)	12.6 m² ×	8.85 ×	1.8	201	207	201
(2)	12.0 m² ×	8.85 ×	2.5	266	273	266
INFILTRATION	CMH ×	deg ×	0.29			
INTERNAL HEAT						
PEOPLE	16 PEOPLE ×	41		656	656	656
Kw	Kw ×	×	860			
LIGHTS	84.5 × 20	W ×	1.08	1826	1826	1826
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m² ×	deg ×		(−)	(−)	
			Sub Total			
SAFETY FACTOR			%			
ROOM SENSIBLE HEAT SUB TOTAL				8592	8549	8031
SUPPLY DUCT HEAT GAIN	+ SUPPLY DUCT LEAK LOSS	+ FAN HP	= 10%	860	855	804
BYPASS OUTSIDE AIR	400 CMH ×	17.7 deg ×	0.1 B.F × 0.29	206	212	212
EFFECTIVE ROOM SENSIBLE HEAT ■				9658	9616	9047
ROOM LATENT HEAT						
INFILTRATION	CMH ×	g/kg ×	0.72			
PEOPLE	16 PEOPLE ×	49		784	784	784
STEAM		kg/h ×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			Sub Total			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				784	780	
SUPPLY DUCT LEAKAGE LOSS			10 %	79	79	
BYPASS OUTSIDE AIR	400 CMH ×	9.4 g/kg × 0.1 BF	× 0.72	271	277	274
EFFECTIVE ROOM LATENT HEAT ■				1134	1136	1133
EFFECTIVE ROOM TOTAL HEAT ■				10792	10752	10180
OUTSIDE AIR HEAT				(128)		
SENSIBLE:	CMH ×	deg × (1 −	BF) × 0.29			
LATENT:	CMH ×	g/kg × (1 −	BF) × 0.72			
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN	+ RETURN DUCT LEAK GAIN	+ PUMP H.P	+ PIPE GAIN = %			
(U.S.R.T) GRAND TOTAL HEAT ■						

ESTIMATE FOR AM PM | PEAK LOAD AM PM 2

HOURS OF OPERATION Hour (~)

OUTSIDE DESIGN CONDITIONS °CDB °CWB %RH

CONDITIONS	DB °C	WB °C	%RH	DP °C	g/kg
OUTSIDE	41.7	28.4	38		18.8
ROOM	24.0	17.1	50		9.4
DIFFERENCE	17.7	×××	×××	×××	9.4

BLIND (NON-EXISTENCE (OUTSIDE, INSIDE) L. M. D

GLASS ORDINARY, THICK, ABSORBENT, %, DOUBLE

COLOR LIGHT, MEDIUM, DARK,

WEIGHT kg/m²(FLOOR) kg/m²(WALL)

INTERNAL HEAT W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE × CMH/PER.	
OPEN DOORS DOORS × CMH/DOOR	
EXHAUST AIR	
CRACK m × CMH/m	
INFILTRATION CMH ■	

VENTILATION

16 PEOPLE × 25 CMH/PER.	400
m² × CMH/m²	
VENTILATION CMH ■	400

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{9.658 \text{ (ERSH)}}{10.792 \text{ (ERTH)}} = 0.91 \ (12.1\,°C)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 °C

$$\frac{9.658 \text{ (ERSH)}}{(24 \text{ RM} - 12.5 \text{ ADP})(1 - 0.1 \text{ BF}) \times 0.29} = 3{,}220 \text{ CMH}$$

NOTES

- GLASS (SE): 1.5×1.8×3 + 1.5×2.8 = 12.3
- WALL (SE): 13.0×4.0 − 12.3 = 39.7
- PARTITION
  - (1): 4.2×3.0 = 12.6
  - (2): 4.0×3.0 = 12.0
- FLOOR: SR

FORM E-201

1028

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

Inquiring No.	
Inquired By	
Job Name	
Address	
Space Used For	CORRIDOR (F09) PAC-2 SYSTEM
Size	m× m= 87.25 m² × 2.5 m(H)= 218.13 m³
Sheet No	37
Date Original	
Revision	
Person in Charge	

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 3:00	Correction 2:00	4:00
SOLAR GAIN — GLASS						
	m²×		×			
	m²×		×			
	m²×		×			
	m²×		×			
	m²×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall	m²×		×			
	m²×		×			
	m²×		×			
	m²×		×			
Roof—Sun	m²×		×			
Roof—Shaded	m²×		×			
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	m²×		×			
Ceiling	m²×		×			
Floor	56.25 m²×	13.2	× 2.5	1857	1786	
Partition	(1) 81.55 m²×	9.1	× 1.8	1336	1299	
	(2) 30.15 m²×	9.1	× 2.5	686	667	
Door	11.34 m²×	9.1	× 1.6	166	161	
Infiltration	CMH×	deg×	0.29			
INTERNAL HEAT						
People		People×				
Kw	Kw×	×	860			
Lights	87.25 × 20 W×		1.08	1885	1885	
Appliances Etc.						
Credit for Thermal Storage	m²×	deg×		(−)	(−)	
			Sub Total			
Safety Factor			%			
Room Sensible Heat Sub Total				5930	5798	
Supply Duct Heat Gain	Supply Duct +Leak Loss	Fan +HP	=10%	593	580	
Bypass Outside Air	CMH×	deg×	BF×0.29			
EFFECTIVE ROOM SENSIBLE HEAT				6523	6378	6378
ROOM LATENT HEAT						
Infiltration	CMH×	g/kg×	0.72			
People		People×				
Steam		kg/h×	540			
Appliances Etc.						
Vapor Trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total						
Supply Duct Leakage Loss			%			
Bypass Outside Air	CMH×	g/kg×	BF×0.72			
EFFECTIVE ROOM LATENT HEAT						
EFFECTIVE ROOM TOTAL HEAT				6523	6378	6378
OUTSIDE AIR HEAT						
Sensible:	CMH×	deg×(1− BF)×0.29				
Latent:	CMH×	g/kg×(1− BF)×0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain ÷ Return Duct Leak Gain ÷ Pump H.P ÷ Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For.	AM PM	Peak Load	AM PM 3
HOURS OF OPERATION	Hour (~)		

Outside Design Conditions: CDB CWB %RH

Conditions	DB ℃	WB ℃	%RH	DP ℃	g/kg
Outside	42.2	28.6	37		19.0
Room	24.0	17.1	50		9.4
Difference	18.2	×××	×××	×××	9.6

BLIND	NON-EXISTENCE(OUTSIDE. INSIDE) L. M. D
GLASS	ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR	LIGHT. MEDIUM. DARK.
WEIGHT	kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT:	W·m² m²/PEOPLE

INFILTRATION

Swinging	
Revolving Doors People× CMH/PER.	
Open Doors Doors× CMH/DOOR	
Exhaust Air	
Crack m× CMH/m	
Infiltration CMH	

VENTILATION

People× CMH/PER.	
m²× CMH/m²	
Ventilation CMH	

SENSIBLE HEAT FACTOR

E.S.H.F = $\frac{6523 \text{ (ERSH)}}{6523 \text{ (ERTH)}}$ = 1.0 (13.2°C)

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 ℃

$\frac{6523 \text{ (ERSH)}}{(24 \text{RM} - 12.5 \text{ADP})(1-\text{BF})\times 0.29}$ = 2180 CMH

NOTES

SR = 26.5×2.5 + 2.0×2.0 + 6.5×2.5 + 2.0
= 87.25

PARTITION
(1) 35.5×2.5 − 0.9×2.1×4 = 81.55
(2) 13.5×2.5 − 0.9×2.0×2 = 30.15

DOOR : 0.9×2.0×6 = 10.8

FLOOR : 2.5 × 22.5 = 56.25

1029

FORM E-20E

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

INQUIRING No.	INQUIRED BY
Job NAME	ADDRESS
SPACE USED FOR EXCUTIVE ENGINEER ROOM (505 d)	PAC-2 SYSTEM
SIZE 3.25 m × 6.5 m = 21.13 m² × 3.8 m(H) = 80.29 m³	

SHEET No 23
DATE ORIGINAL
REVISION
PERSON IN CHARGE

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF	FACTOR	Kcal/h MAX: 12:00	CORRECTION 3:00	4:00
SOLAR GAIN — GLASS						
(SE)	4.2 m²×	252 × 1.57/0.85 ×	0.94 × 0.65	434	183	160
	m²×	×				
	m²×	×				(221)
	m²×	×				
	m²×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (SE)	8.8 m²×	13.6 ×	2.1	252	239	230
	m²×	×				
	m²×	×				(257)
	m²×	×				
ROOF—SUN	m²×	×				
ROOF—SHADED	m²×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	4.2 m²×	14.4 ×	5.1	309	393	354
CEILING	m²×	×				(354)
FLOOR	m²×	×				
PARTITION	15.2 m²×	7.2 ×	1.8	197	249	243
						(243)
INFILTRATION	CMH×	deg×	0.29			
INTERNAL HEAT						
PEOPLE	2 PEOPLE× 41			82	82	82
KW	KW×	×	860			
LIGHTS	21.13 × 20 W×		1.08	457	457	457
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m²×	deg×		(−)	(−)	
			Sub TOTAL			
SAFETY FACTOR			%			(1614)
ROOM SENSIBLE HEAT SUB TOTAL				1731	1603	1526
SUPPLY DUCT HEAT GAIN	+ SUPPLY DUCT LEAK LOSS	+ FAN HP	= 10%	174	161	153 (162)
BYPASS OUTSIDE AIR	50 CMH × 14.4 deg × 0.1 B.F × 0.29			21	27	24
EFFECTIVE ROOM SENSIBLE HEAT				1926	1791	1703
ROOM LATENT HEAT						(1800)
INFILTRATION	CMH×	g/kg×	0.72			
PEOPLE	2 PEOPLE× 49			98		
STEAM		kg/h×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			Sub TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				98	98	98
SUPPLY DUCT LEAKAGE LOSS			10 %	10	10	10
BYPASS OUTSIDE AIR	50 CMH × 9.5 g/kg × 0.1 BF × 0.72			35	35	34
EFFECTIVE ROOM LATENT HEAT				143	143	142
EFFECTIVE ROOM TOTAL HEAT				2069	1934	1845
OUTSIDE AIR HEAT				(98)		
SENSIBLE:	CMH×	deg×(1−	BF)×0.29			
LATENT:	CMH×	g/kg×(1−	BF)×0.72			
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN	+ RETURN DUCT LEAK GAIN	+ PUMP H.P	+ PIPE GAIN = %			
(U.S.R.T) GRAND TOTAL HEAT						

(2:00) : 1942

ESTIMATE FOR AM/PM — PEAK LOAD 12 AM/PM

HOURS OF OPERATION Hour (—)

OUTSIDE DESIGN CONDITIONS °CDB °CWB %RH

CONDITIONS	DB °C	WB °C	%RH	DP °C	g/kg
OUTSIDE	38.4	27.6	43		18.9
ROOM	24.0	17.1	50		9.4
DIFFERENCE	14.4	×××	×××	×××	9.5

BLIND	(NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS	ORDINARY, THICK, ABSORBENT. %. DOUBLE
COLOR	LIGHT, MEDIUM, DARK
WEIGHT	kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT	W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE× CMH/PER.	
OPEN DOORS DOORS× CMH/DOOR	
EXHAUST AIR	
CRACK m× CMH/m	
INFILTRATION CMH	

VENTILATION

2 PEOPLE× 25 CMH/PER.	50
m²× CMH/m²	
VENTILATION CMH	50

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{1.926\ (ERSH)}{2.069\ (ERTH)} = 0.93\ (12.3°C)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 °C

$$\frac{1926\ (ERSH)}{(24RM - 12.5ADP)(1 - 0.1BF) \times 0.29} = 620\ CMH$$

NOTES

- GLASS (SE) : 1.5 × 2.8 = 4.2
- WALL (SE) : 3.25 × 4.0 − 4.2 = 8.8
- PARTITION : 4.0 × 3.8 = 15.2

FORM E-20E

1030

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

Sheet No. 31
Date Original
Revision
Person in Charge

Inquiring No. | Inquired By
Job Name | Address
Space Used For: EXECUTIVE ENGINEER ROOM (505b, 505c) PAC-Z SYSTEM
Size 6.5 m × 3.25 m = 21.13 m² × 3.8 m(H) = 80.29 m³

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 12:00	Correction 3:00	Correction 4:00
SOLAR GAIN — GLASS						
(SE)	4.2 m² ×	252 × 0.57/0.85 ×	0.94 × 0.65	434	183	160
	m² ×	×				
	m² ×	×				(221)
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (SE)	8.8 m² ×	13.6 ×	2.1	252	239	230
	m² ×	×				
	m² ×	×				(259)
	m² ×	×				
Roof—Sun	m² ×	×				
Roof—Shaded	m² ×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	4.2 m² ×	14.4 ×	5.1	309	393	354
Ceiling	m² ×	×				
Floor	m² ×	×				(354)
Partition	m² ×	×				
Infiltration	CMH ×	deg ×	0.29			
INTERNAL HEAT						
People	2 People ×	41		82	82	82
Kw	Kw ×	×	860			
Lights	21.13 × 20 W ×		1.08	457	457	457
Appliances etc.						
Credit for Thermal Storage	m² ×	deg ×		(−)	(−)	
			Sub Total			
Safety Factor			%			(1371)
Room Sensible Heat Sub Total				1534	1354	1283
Supply Duct Heat Gain + Supply Duct Leak Loss + Fan HP			10 %	154	136	(138) 129
Bypass Outside Air	50 CMH ×	14.4 deg ×	0.1 BF × 0.29	21	27	26
EFFECTIVE ROOM SENSIBLE HEAT				1709	1517	1438
ROOM LATENT HEAT						(1673)
Infiltration	CMH ×	g/kg ×	0.72			
People	2 People ×	49		98		
Steam		kg/h ×	540			
Appliances etc.						
Vapor trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total				98	98	98
Supply Duct Leakage Loss			10 %	10	10	10
Bypass Outside Air	50 CMH ×	9.5 g/kg ×	0.1 BF × 0.72	35	35	34
EFFECTIVE ROOM LATENT HEAT				143	143	142
EFFECTIVE ROOM TOTAL HEAT				1852	1660	1580
OUTSIDE AIR HEAT				(88)		
Sensible:	CMH ×	deg × (1 − BF) × 0.29				
Latent:	CMH ×	g/kg × (1 − BF) × 0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain − Pump H.P − Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For: AM / PM — Peak Load: AM / PM 12

Hours of Operation: Hour (~)

Outside Design Conditions: °CDB, °CWB, %RH

Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	38.4	27.6	43		18.9
Room	24.0	17.1	50		9.4
Difference	14.4	×××	×××	×××	9.5

Blind: Non-existence (Outside, Inside) L. M. D
Glass: Ordinary, Thick, Absorbent. %. Double
Color: Light, Medium, Dark.
Weight: kg/m² (Floor) kg/m² (Wall)
Internal Heat: W/m² m²/People

INFILTRATION

Swinging
Revolving Doors: People × CMH/Per.
Open Doors: Doors × CMH/Door
Exhaust Air
Crack: m × CMH/m
Infiltration: CMH

VENTILATION

2 People × 25 CMH/Per. — 50
m² × CMH/m²
Ventilation: CMH — 50

SENSIBLE HEAT FACTOR

E.S.H.F = 1.709 (ERSH) / 1.852 (ERTH) = 0.92 (12.3°C)

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

1.709 (ERSH) / (24 RM − 12.5 ADP)(1 − 0.1 BF) × 0.29 = 550 CMH

NOTES
GLASS (SE) : 4.2
WALL (SE) : 8.8

(2:00) 1815

103

FORM E-20E

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

SHEET No. 35
DATE ORIGINAL
REVISION
PERSON IN CHARGE

INQUIRING No. | INQUIRED BY
JOB NAME | ADDRESS
SPACE USED FOR EXCUTIVE ENGINER ROOM (505 a) PAC-2 SYSTEM
SIZE 3.25 m × 6.5 m = 21.13 m² × 3.8 m(H) = 80.29 m³

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h MAX 12:00	CORRECTION 3:00	CORRECTION 4:00
SOLAR GAIN — GLASS						
(SE)	4.2 m² × 252 × 0.57/0.85	× 0.94	× 0.65	434	183	160
	m² ×	×				
	m² ×	×				(221)
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (SE)	8.8 m² ×	13.6 ×	2.1	252	239	230
	m² ×	×				
	m² ×	×				(257)
	m² ×	×				
ROOF—SUN	m² ×	×				
ROOF—SHADED	m² ×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	4.2 m² ×	14.4 ×	5.1	309	393	354
CEILING	m² ×	×				(354)
FLOOR	m² ×	×				
PARTITION	15.2 m² ×	17.2 ×	2.5	274	346	337
						(337)
INFILTRATION	CMH ×	deg ×	0.29			
INTERNAL HEAT						
PEOPLE	2 PEOPLE × 41			82	82	82
KW	KW ×	×	860			
LIGHTS	21.13 × 20 W ×		1.08	457	457	457
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m² ×	deg ×		(—)	(—)	
			SUB TOTAL			
SAFETY FACTOR			%			(1708)
ROOM SENSIBLE HEAT SUB TOTAL				1808	1700	1620
SUPPLY DUCT HEAT GAIN	+ SUPPLY DUCT LEAK LOSS	+ FAN HP	= 10%	181	170	(171) 162
BYPASS OUTSIDE AIR	50 CMH × 14.4 deg × 0.1 B.F. × 0.29			21	27	26
EFFECTIVE ROOM SENSIBLE HEAT ■				2010	1897	1808
ROOM LATENT HEAT						(1905)
INFILTRATION	CMH ×	g/kg ×	0.72			
PEOPLE	2 PEOPLE × 49			98		
STEAM		kg/h ×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				98		
SUPPLY DUCT LEAKAGE LOSS			10 %	10		
BYPASS OUTSIDE AIR	CMH × 9.5 g/kg × 0.1 BF × 0.72			35	35	34
EFFECTIVE ROOM LATENT HEAT ■				143	143	142
EFFECTIVE ROOM TOTAL HEAT				2153	2040	1950
OUTSIDE AIR HEAT						
SENSIBLE:	CMH ×	deg × (1 − BF) × 0.29				
LATENT:	CMH ×	g/kg × (1 − BF) × 0.72				
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN	+ RETURN DUCT LEAK GAIN	+ PUMP H.P	+ PIPE GAIN = %			
(U.S.R.T) GRAND TOTAL HEAT						

(2:00) : 2067

ESTIMATE FOR. AM/PM | PEAK LOAD AM/PM 12

HOURS OF OPERATION Hour (~)

OUTSIDE DESIGN CONDITIONS °CDB °CWB %RH

CONDITIONS	DB °C	WB °C	%RH	DP °C	g/kg
OUTSIDE	38.4	27.6	43		18.9
ROOM	24.0	17.1	50		9.4
DIFFERENCE	14.4	×××	×××	×××	9.5

BLIND | NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS | ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR | LIGHT. MEDIUM. DARK.
WEIGHT | kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT: W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE × CMH/PER.	
OPEN DOORS DOORS × CMH/DOOR	
EXHAUST AIR	
CRACK m × CMH/m	
INFILTRATION CMH ■	

VENTILATION

2 PEOPLE × 25 CMH/PER.	50
m² × CMH/m²	
VENTILATION CMH ■	50

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{2010 \ (ERSH)}{2153 \ (ERTH)} = 0.93 \ (12.3°C)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 °C

$$\frac{2010 \ (ERSH)}{(24\ RM - 12.5\ ADP)(1 - 0.1\ BF) \times 0.29} = \_\_\_\_ \ CMH$$

NOTES
GLASS(SE) : 1.5 × 2.8 = 4.2
WALL (SE) : 3.25 × 4 − 4.2 = 8.8
PARTITION : 4.0 × 3.8 = 15.2

FORM E-20E

1051

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

INQUIRING No.	INQUIRED BY		SHEET No. 36
JOB NAME	ADDRESS		DATE ORIGINAL
SPACE USED FOR PRAY ROOM (504)	PAC-2 SYSTEM		REVISION
SIZE 6.5 m × 6.5 m = 47.25 m²	× 3.8 m(H) = 160.55 m³		PERSON IN CHARGE

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP. DIFF.	FACTOR	Kcal/h MAX 3:00	CORRECTION 2:00	CORRECTION 4:00
SOLAR GAIN — GLASS						
(SE)	6.9 m² ×	252 × 0.24/0.85	× 0.94 × 0.65	300	363	263
(SW)	5.4 m² ×	252 × 0.7/0.85	× 0.94 × 0.65	685	646	627
	m² ×		×			
	m² ×		×			
	m² ×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (SE)	19.1 m² ×	12.9	× 2.1	518	558	498
(SW)	20.6 m² ×	15.8	× 2.1	684	524	805
	m² ×		×			
	m² ×		×			
ROOF—SUN	m² ×		×			
ROOF—SHADED	m² ×		×			
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	6.9 m² ×	18.2	× 5.1	641	623	623
CEILING	m² ×		×			
FLOOR	42.25 m² ×	9.1	× 1.7	654	636	636
PARTITION	15.2 m² ×	9.1	× 1.8	249	243	243
INFILTRATION	CMH ×	deg ×	0.29			
INTERNAL HEAT						
PEOPLE	12 PEOPLE ×	41		492	492	492
KW	KW ×	×	860			
LIGHTS	47.25 × 20 W ×		1.08	913	913	913
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m² ×	deg ×		(−)		(−)
			SUB TOTAL			
SAFETY FACTOR			%	5136	4998	5100
ROOM SENSIBLE HEAT SUB TOTAL						
SUPPLY DUCT HEAT GAIN + SUPPLY DUCT LEAK LOSS + FAN HP			=10%	514	500	510
BYPASS OUTSIDE AIR	300 CMH ×	18.2 deg ×	0.1 BF × 0.29	159	154	154
EFFECTIVE ROOM SENSIBLE HEAT				5809	5652	5764
ROOM LATENT HEAT						
INFILTRATION	CMH ×	g/kg ×	0.72			
PEOPLE	12 PEOPLE ×	49		588		
STEAM		kg/h ×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL				588	588	588
SUPPLY DUCT LEAKAGE LOSS			10 %	59	59	59
BYPASS OUTSIDE AIR	300 CMH ×	9.6 g/kg ×	0.1 BF × 0.72	208	203	203
EFFECTIVE ROOM LATENT HEAT				855	850	850
EFFECTIVE ROOM TOTAL HEAT				6664	6502	6614
OUTSIDE AIR HEAT						
SENSIBLE:	CMH ×	deg × (1 − BF) × 0.29				
LATENT:	CMH ×	g/kg × (1 − BF) × 0.72				
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN + RETURN DUCT LEAK GAIN − PUMP H.P − PIPE GAIN			= %			
(U.S.R.T) GRAND TOTAL HEAT						

ESTIMATE FOR	AM / PM	PEAK LOAD	AM / PM 3
HOURS OF OPERATION	HOUR (~)		

OUTSIDE DESIGN CONDITIONS	CDB	CWB	%RH		
CONDITIONS	DB ℃	WB ℃	%RH	DP ℃	g/kg
OUTSIDE	42.2	28.6	37		19.0
ROOM	24.0	17.1	50		9.4
DIFFERENCE	18.2	×××	×××	×××	9.6

BLIND	NON-EXISTENCE (OUTSIDE, INSIDE) L. M. D
GLASS	ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR	LIGHT. MEDIUM. DARK.
WEIGHT	kg/m² (FLOOR) kg/m² (WALL)
INTERNAL HEAT	W/m² m²/PEOPLE

INFILTRATION

SWINGING	
REVOLVING DOORS PEOPLE × CMH/PER	
OPEN DOORS DOORS × CMH/DOOR	
EXHAUST AIR	
CRACK m × CMH/m	
INFILTRATION CMH	

VENTILATION

12 PEOPLE × 25 CMH/PER.	300
m² × CMH/m²	
VENTILATION CMH	300

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{5809 \ (ERSH)}{6664 \ (ERTH)} = 0.87 \ (11.8℃)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 ℃

$$\frac{5809 \ (ERSH)}{(24 \ RM - 12.5 \ ADP)(1 - 0.1 \ BF) \times 0.29} = 1940 \ CMH$$

NOTES

GLASS (SE): 1.5 × 1.8 + 1.5 × 2.8 = 6.9

WALL (SE): 6.5 × 4.0 − 6.9 = 19.1

PARTITION: 4.0 × 3.8 = 15.2

GLASS (SW): 1.5 × 1.8 × 2 = 5.4

WALL (SW): 6.5 × 4.0 − 5.4 = 20.6

FORM E-20

1033

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

INQUIRING No.	INQUIRED BY
JOB NAME	ADDRESS
SPACE USED FOR CORRIDOR (S06)	AC-2 SYSTEM
SIZE m× m= 101.5 m² × 2.5 m(H)= 253.75 m³	

SHEET No. 37
DATE ORIGINAL
REVISION
PERSON IN CHARGE

ITEM	AREA OR QUANTITY	SUN GAIN OR TEMP DIFF.	FACTOR	Kcal/h	CORRECTION	
SOLAR GAIN — GLASS				MAX 3:00	2:00	4:00
(SW)	4.2 m²×	252 × 0.7/0.85 × 0.94 × 0.65		533	503	487
	m²×	×				
	m²×	×				
	m²×	×				
	m²×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
WALL (SW)	5.8 m²×	15.8	× 2.1	193	148	227
	m²×	×				
	m²×	×				
	m²×	×				
ROOF—SUN	m²×	×				
ROOF—SHADED	m²×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
GLASS	4.2 m²×	18.2	× 5.1	390	380	380
CEILING	m²×	×				
FLOOR	m²×	×				
PARTITION (1)	30.15 m²×	9.1	× 1.8	494	481	481
(2)	33.2 m²×	9.1	× 2.5	756	735	735
DOOR	5.4 m²×	9.1	× 1.6	79	77	77
INFILTRATION	CMH×	deg×	0.29			
INTERNAL HEAT						
PEOPLE		PEOPLE×				
KW	KW×	×	860			
LIGHTS	101.5×20 W×		1.08	2193	2193	2193
APPLIANCES ETC.						
CREDIT FOR THERMAL STORAGE	m²×	deg×		(−)	(−)	
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM SENSIBLE HEAT SUB TOTAL				4638	4517	4580
SUPPLY DUCT HEAT GAIN	SUPPLY DUCT ÷ LEAK LOSS	FAN ÷ HP	=10%	464	452	458
BYPASS OUTSIDE AIR	CMH×	deg×	B.F.×0.29			
EFFECTIVE ROOM SENSIBLE HEAT				5102	4969	5038
ROOM LATENT HEAT						
INFILTRATION	CMH×	g/kg×	0.72			
PEOPLE		PEOPLE×				
STEAM		kg/h×	540			
APPLIANCES ETC.						
VAPOR TRANS.						
			SUB TOTAL			
SAFETY FACTOR			%			
ROOM LATENT HEAT SUB TOTAL						
SUPPLY DUCT LEAKAGE LOSS			%			
BYPASS OUTSIDE AIR	CMH×	g/kg×	BF×0.72			
EFFECTIVE ROOM LATENT HEAT						
EFFECTIVE ROOM TOTAL HEAT				5102	4969	5038
OUTSIDE AIR HEAT						
SENSIBLE:	CMH×	deg×(1−	BF)×0.29			
LATENT:	CMH×	g/kg×(1−	BF)×0.72			
GRAND TOTAL HEAT SUB TOTAL						
RETURN DUCT HEAT GAIN	÷ RETURN DUCT LEAK GAIN	− PUMP H.P	÷ PIPE GAIN = %			
(U.S.R.T) GRAND TOTAL HEAT						

ESTIMATE FOR.	AM PM	PEAK LOAD	AM PM 3		
HOURS OF OPERATION	HOUR (	~	)		
OUTSIDE DESIGN CONDITIONS		CDB	CWB	%RH	
CONDITIONS	DB ℃	WB ℃	%RH	DP ℃	g/kg
OUTSIDE	42.2	28.6	37		19.0
ROOM	24.0	17.1	50		9.4
DIFFERENCE	18.2	×××	×××	×××	9.6

BLIND: NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS: ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR: LIGHT. MEDIUM. DARK.
WEIGHT: kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT: W·m² m²/PEOPLE

INFILTRATION
SWINGING
REVOLVING DOORS PEOPLE× CMH/PER.
OPEN DOORS DOORS× CMH/DOOR
EXHAUST AIR
CRACK m× CMH/m
INFILTRATION CMH

VENTILATION
PEOPLE× CMH/PER.
m²× CMH/m²
VENTILATION CMH

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{5102 \ (ERSH)}{5102 \ (ERTH)} = 1.0 \ (13.2)$$

DEHUMIDIFIED AIR

APPARATUS DEWPOINT 12.5 ℃

$$\frac{5102 \ (ERSH)}{24\ RM-(12.5 ADP)(1-, BF)\times 0.29} = 1680 \text{ CMH}$$

NOTES

SR = 32.5×2.5 + 2.0×2.0 + 6.5×2.5 = 101.5

GLASS (SW): 1.5×2.8 = 4.2

WALL (SW): 2.5×4.0 − 4.2 = 5.8

PARTITION
(1): 13.5×2.5 − 3.6 = 30.15
(2): 14.0×2.5 − 1.8 = 33.2

DOOR: 0.9×2.0×3 = 5.4

FORM E-20E

1034

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

Inquiring No.	Inquired By
Job Name	Address
Space Used For EXCUTIVE ENGINEER ROOM (T03d) PAC-2 SYSTEM	
Size 3.25 m × 6.5 m = 21.13 m² × 3.8 m(H) = 80.29 m³	

Sheet No.	38
Date Original	
Revision	
Person in Charge	

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 4:00	Correction 2:00	Correction 3:00
SOLAR GAIN — GLASS						
(SE)	4.2 m² ×	252 × 0.21/0.85	× 0.94 × 0.65	160	221	183
	m² ×		×			
	m² ×		×			
	m² ×		×			
	m² ×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (SE)	8.8 m² ×	12.4	× 2.1	230	257	239
	m² ×		×			
	m² ×		×			
	m² ×		×			
Roof—Sun	21.13 m² ×	26.2	× 1.7	942	762	863
Roof—Shaded	m² ×		×			
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	4.2 m² ×	17.7	× 5.1	380	380	390
Ceiling	m² ×		×			
Floor	m² ×		×			
Partition	15.2 m² ×	8.85	× 1.8	243	243	249
Infiltration	CMH ×	deg ×	0.29			
INTERNAL HEAT						
People	2 People ×	41		82	82	82
Kw	Kw ×	×	860			
Lights	21.13 × 20 W ×		1.08	457	457	457
Appliances Etc.						
Credit for Thermal Storage	m² ×	deg ×		(−)	(−)	
Sub Total						
Safety Factor			%			
Room Sensible Heat Sub Total				2494	2402	2463
Supply Duct Heat Gain + Supply Duct Leak Loss + Fan HP			=10%	250	241	247
Bypass Outside Air	50 CMH × 17.7 deg × 0.1 B.F × 0.29			26	26	27
EFFECTIVE ROOM SENSIBLE HEAT				2770	2669	2737
ROOM LATENT HEAT						
Infiltration	CMH ×	g/kg ×	0.72			
People	2 People ×	49		98		
Steam		kg/h ×	540			
Appliances Etc.						
Vapor Trans.						
Sub Total						
Safety Factor			%			
Room Latent Heat Sub Total				98	98	98
Supply Duct Leakage Loss			10 %	10	10	10
Bypass Outside Air	50 CMH × 9.4 g/kg × 0.1 BF × 0.72			34	34	35
EFFECTIVE ROOM LATENT HEAT				142	142	143
EFFECTIVE ROOM TOTAL HEAT				2912	2811	2880
OUTSIDE AIR HEAT				(138)		
Sensible:	CMH ×	deg × (1 − BF) × 0.29				
Latent:	CMH ×	g/kg × (1 − BF) × 0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain + Pump H.P + Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For: AM PM — Peak Load: AM PM 4

Hours of Operation: Hour (–)

Outside Design Conditions: °CDB °CWB %RH

Conditions	DB ℃	WB ℃	%RH	DP ℃	g/kg
Outside	41.7	28.4	38		18.8
Room	24.0	17.1	50		9.4
Difference	17.7	×××	×××	×××	9.4

Blind	Non-existence (outside, inside) L, M, D
Glass	Ordinary, thick, absorbent. %, double
Color	Light, medium, dark
Weight	kg/m² (floor) kg/m² (wall)
Internal Heat	W/m² m²/people

INFILTRATION	
Swinging	
Revolving Doors People × CMH/PER.	
Open Doors Doors × CMH/DOOR	
Exhaust Air	
Crack m × CMH/m	
Infiltration CMH	

VENTILATION	
2 People × 25 CMH/PER.	50
m² × CMH/m²	
Ventilation CMH	50

SENSIBLE HEAT FACTOR

E.S.H.F = 2,770 (ERSH) / 2,912 (ERTH) = 0.95 (12.5℃)

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 ℃

$$\frac{2{,}770\ (ERSH)}{(24RM - 12.5ADP)(1 - 0.1BF) \times 0.29} = 920\ CMH$$

NOTES

GLASS (SE) : 1.5 × 2.8 = 4.2

WALL (SE) : 3.25 × 4.0 − 4.2 = 8.8

PARTITION : 4.0 × 3.8 = 15.2

ROOF : SR

FORM E-20E

103

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

Inquiring No	Inquired By
Job Name	Address
Space Used For EXCUTIVE ENGINEER ROOM (T03C, T03H) PAC-2 SYSTEM	
Size 3.25 m× 6.5 m= 21.13 m² × 3.8 m(H)= 80.29 m³	

Sheet No. 39
DATE ORIGINAL
REVISION
PERSON IN CHARGE

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 4:00	Correction 2:00	3:00
SOLAR GAIN — GLASS						
(SE) 4.2	m²×252×0.21/0.85×0.94×0.65			160	221	183
	m²×	×				
	m²×	×				
	m²×	×				
	m²×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (SE) 8.8	m²×	12.4	× 2.1	230	257	239
	m²×	×				
	m²×	×				
	m²×	×				
Roof—Sun 21.13	m²×	26.2	× 1.7	942	762	863
Roof—Shaded	m²×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass 4.2	m²×	17.7	× 5.1	380	380	390
Ceiling	m²×	×				
Floor	m²×	×				
Partition	m²×	×				
Infiltration	CMH×	deg×	0.29			
INTERNAL HEAT						
People	2 People×	41		82	82	82
Kw	Kw×	×	860			
Lights	21.13 × 20 W×		1.08	457	457	457
Appliances Etc.						
Credit for Thermal Storage	m²×	deg×		(—)	(—)	
			Sub Total			
Safety Factor			%			
Room Sensible Heat Sub Total				2251	2159	2214
Supply Duct Heat Gain + Supply Duct Leak Loss + FAN HP			=16 %	226	216	222
Bypass Outside Air	50 CMH×17.7 deg×0.1 B.F×0.29			26	26	27
EFFECTIVE ROOM SENSIBLE HEAT				2503	2401	2463
ROOM LATENT HEAT						
Infiltration	CMH×	g/kg×	0.72			
People	2 People×	49		98		
Steam		kg/h×	540			
Appliances Etc.						
Vapor Trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total				98	98	98
Supply Duct Leakage Loss			10 %	10	10	10
Bypass Outside Air	50 CMH×9.4 g/kg×0.1 BF×0.72			34	34	35
EFFECTIVE ROOM LATENT HEAT				143	142	143
EFFECTIVE ROOM TOTAL HEAT				2646	2543	2606
OUTSIDE AIR HEAT						
Sensible:	CMH×	deg×(1− BF)×0.29				
Latent:	CMH×	g/kg×(1− BF)×0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain + Pump H.P + Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For.	AM PM	Peak Load	AM PM 4

HOURS OF OPERATION Hour (~)

Outside Design Conditions	°CDB	°CWB	%RH		
Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	41.7	28.4	38		18.8
Room	24.0	17.1	50		9.4
Difference	17.7	×××	×××	×××	9.4

BLIND: NON-EXISTENCE (OUTSIDE, INSIDE) L. M. D
GLASS: ORDINARY, THICK, ABSORBENT. %, DOUBLE
COLOR: LIGHT, MEDIUM, DARK.
WEIGHT: kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT: W·m² m²/PEOPLE

INFILTRATION	
Swinging	
Revolving Doors People× CMH/PER.	
Open Doors Doors× CMH/DOOR	
Exhaust Air	
Crack m× CMH/m	
Infiltration CMH	
VENTILATION	
2 People× 25 CMH/PER.	50
m²× CMH/m²	
Ventilation CMH	50

SENSIBLE HEAT FACTOR

E.S.H.F = 2503 (ERSH) / 2646 (ERTH) = 0.95 (12.5°C)

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

2503 (ERSH) / (24 RM − 12.5 ADP)(1 − 0.1 BF)×0.29 = 830 CMH

NOTES
GLASS (SE) : 1.5×2.8 = 4.2
WALL (SE) : 3.25×4.0 − 4.2 = 8.8
ROOF : SR

FORM E-20E

1036

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

Inquiring No.	Inquired By
Job Name	Address
Space Used For EXEUTIVE ENGINEER ROOM (T03a) PAC-2 SYSTEM	
Size 3.25 m × 6.5 m = 21.13 m² × 3.8 m H = 80.29 m³	

Sheet No. 40
DATE ORIGINAL
REVISION
PERSON IN CHARGE

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 4:00	Correction 2:00	Correction 3:00
SOLAR GAIN — GLASS						
(SE)	4.2 m² ×	252 × 0.31/0.85 × 0.94 × 0.65		160	221	183
	m² ×	×				
	m² ×	×				
	m² ×	×				
	m² ×	×				
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (SE)	8.8 m² ×	12.4 ×	2.1	230	257	239
	m² ×	×				
	m² ×	×				
	m² ×	×				
Roof—Sun	21.13 m² ×	26.2 ×	1.7	942	762	863
Roof—Shaded	m² ×	×				
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	4.2 m² ×	17.7 ×	5.1	380	380	390
Ceiling	m² ×	×				
Floor	m² ×	×				
Partition	15.2 m² ×	8.85 ×	2.5	337	337	346
Infiltration	CMH ×	deg ×	0.29			
INTERNAL HEAT						
People	2 People ×	41		82	82	82
Kw	Kw ×	×	860			
Lights	21.13 × 20 W ×		1.08	457	457	457
Appliances etc.						
Credit for Thermal Storage	m² ×	deg ×		(−)	(−)	
		Sub Total				
Safety Factor			%			
Room Sensible Heat Sub Total				2,588	2496	2560
Supply Duct Heat Gain + Supply Duct Leak Loss + Fan HP			= 10%	259	250	256
Bypass Outside Air	50 CMH × 17.7 deg × 0.1 BF × 0.29			26	26	27
EFFECTIVE ROOM SENSIBLE HEAT				2873	2772	2843
ROOM LATENT HEAT						
Infiltration	CMH ×	g/kg ×	0.72			
People	2 People ×	49		98		
Steam		kg/h ×	540			
Appliances etc.						
Vapor trans.						
		Sub Total				
Safety Factor			%			
Room Latent Heat Sub Total				98	98	98
Supply Duct Leakage Loss			10 %	10	10	10
Bypass Outside Air	CMH × 9.4 g/kg × 0.1 BF × 0.72			34	34	35
EFFECTIVE ROOM LATENT HEAT				142	142	143
EFFECTIVE ROOM TOTAL HEAT				3,015	2914	2986
OUTSIDE AIR HEAT				(143)		
Sensible:	CMH ×	deg × (1 − BF) × 0.29				
Latent:	CMH ×	g/kg × (1 − BF) × 0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain + Pump H.P + Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For: AM / PM   Peak Load: AM / PM 4

HOURS OF OPERATION Hour (~)

Outside Design Conditions: °CDB °CWB %RH

Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	41.7	28.4	38		18.8
Room	24.0	17.1	50		9.9
Difference	17.7	×××	×××	×××	9.4

BLIND	NON-EXISTENCE (OUTSIDE, INSIDE) L. M. D
GLASS	ORDINARY, THICK, ABSORBENT, %, DOUBLE
COLOR	LIGHT, MEDIUM, DARK
WEIGHT	kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT	W/m² m²/PEOPLE

INFILTRATION

Swinging	
Revolving Doors — People × CMH/PER.	
Open Doors — Doors × CMH/DOOR	
Exhaust Air	
Crack — m × CMH/m	
Infiltration CMH	

VENTILATION

2 People × 25 CMH/PER.	50
m² × CMH/m²	
Ventilation CMH	50

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{2.873\ (ERSH)}{3.015\ (ERTH)} = 0.95\ (12.5°C)$$

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

$$\frac{2873\ (ERSH)}{(24\,RM - 12.5\,ADP)(1 - 0.1\,BF) \times 0.29} = 960\ CMH$$

NOTES

GLASS(SE): 1.5×2.8 = 4.2

WALL(SE): 3.25×4.0 − 4.2 = 8.8

PARTITION: 4.0×3.8 = 15.2

ROOF: SR

FORM E-20E

1027

COOLING AND DEHUMIDIFYING ESTIMATE(METRIC)

Inquiring No.	Inquired By
Job Name	Address
Space Used For LIBRARY & STRAGE ROOM (702) . PAC-2 SYSTEM	
Size 6.5 m × 6.5 m = 42.25 m² × 3.8 m(H) = 160.55 m³	

Sheet No.	41
Date Original	
Revision	
Person in Charge	

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	Kcal/h MAX 4:00	Correction 2:00	Correction 3:00
SOLAR GAIN — GLASS						
(SW)	5.4 m² ×	252 × 0.64/6.85 × 0.94 × 0.65		627	646	685
(SE)	6.9 m² ×	252 × 0.21/6.85 × 0.94 × 0.65		263	363	300
	m² ×		×			
	m² ×		×			
	m² ×		×			
SOLAR & TRANS GAIN—WALLS & ROOF						
Wall (SW)	20.6 m² ×	18.6	× 2.1	805	524	684
(SE)	19.1 m² ×	12.4	× 2.1	498	558	518
	m² ×		×			
	m² ×		×			
Roof—Sun	36.25 m² ×	26.2	× 1.7	1625	1307	1479
Roof—Shaded	m² ×		×			
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	12.3 m² ×	17.7	× 5.1	1111	1111	1142
Ceiling	6.0 m² ×	8.85	× 1.4	75	75	77
Floor	m² ×		×			
Partition	15.2 m² ×	8.85	× 1.8	243	243	249
Infiltration	CMH ×	deg ×	0.29			
INTERNAL HEAT						
People	4 People ×		41	164	164	164
Kw	Kw ×		× 860			
Lights	42.25 × 20 W ×		1.08	913	913	913
Appliances Etc.						
Credit for Thermal Storage	m² ×	deg ×		(−)	(−)	
			Sub Total			
Safety Factor			%			
Room Sensible Heat Sub Total				6324	4904	6211
Supply Duct Heat Gain + Supply Duct Leak Loss + Fan HP			= 10%	633	491	622
Bypass Outside Air	100 CMH × 17.7 deg × 0.1 BF × 0.29			52	52	53
EFFECTIVE ROOM SENSIBLE HEAT				7009	5447	6886
ROOM LATENT HEAT						
Infiltration	CMH ×	g/kg ×	0.72			
People	4 People ×		49	196		
Steam		kg/h ×	540			
Appliances Etc.						
Vapor Trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total				196	196	196
Supply Duct Leakage Loss			10 %	20	20	20
Bypass Outside Air	100 CMH × 9.4 g/kg × 0.1 BF × 0.72			68	68	70
EFFECTIVE ROOM LATENT HEAT				284	284	286
EFFECTIVE ROOM TOTAL HEAT				7293	5731	7172
OUTSIDE AIR HEAT				(173)		
Sensible:	CMH ×	deg × (1 − BF) × 0.29				
Latent:	CMH ×	g/kg × (1 − BF) × 0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain − Pump H.P + Pipe Gain			= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For. AM/PM	Peak Load AM/PM 4
HOURS OF OPERATION	Hour (~)

Outside Design Conditions °CDB °CWB %RH

Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	41.7	28.4	38		18.8
Room	24.0	17.1	50		9.4
Difference	17.7	×××	×××	×××	9.4

BLIND	NON-EXISTENCE(OUTSIDE, INSIDE) L. M. D
GLASS	ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR	LIGHT. MEDIUM. DARK.
WEIGHT	kg/m²(FLOOR) kg/m²(WALL)
INTERNAL HEAT	W/m² m²/PEOPLE

INFILTRATION

Swinging	
Revolving Doors People × CMH/PER.	
Open Doors Doors × CMH/DOOR	
Exhaust Air	
Crack m × CMH/m	
Infiltration CMH	

VENTILATION

4 People × 25 CMH/PER.	100
m² × CMH/m²	
Ventilation CMH	100

SENSIBLE HEAT FACTOR

E.S.H.F = 7009 (ERSH) / 7293 (ERTH) = 0.96 (12.6°C)

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

7009 (ERSH) / (24 RM − 12.5 ADP)(1 − 0.1 BF) × 0.29 = 2.340 CMH

NOTES

GLASS (SW) : 1.5 × 1.8 × 2 = 5.4

(SE) : 1.5 × 1.8 + 1.5 × 2.8 = 6.9

WALL (SW) : 6.5 × 4.0 − 5.4 = 20.6

(SE) : 6.5 × 4.0 − 6.9 = 19.1

PARTITION ; 4.0 × 3.8 = 15.2

ROOF : SR − 6.0 = 36.25

CEILING : 3.0 × 2.0 = 6.0

FORM E-20E

108

COOLING AND DEHUMIDIFYING ESTIMATE (METRIC)

Sheet No. 47
Date Original
Revision
Person in Charge

Inquiring No.
Inquired By
Job Name
Address
Space Used For CORRIDOR (T04) — PAC-2 SYSTEM
Size m× m= 101.5 m² × 2.5 m(H)= 253.75 m³

Item	Area or Quantity	Sun Gain or Temp. Diff.	Factor	MAX 4:00	Correction 2:00	Correction 3:00
SOLAR GAIN — GLASS						
(SW)	4.2 m²×	253×0.14/0.85	×0.94×0.65	487	503	533
	m²×		×			
	m²×		×			
	m²×		×			
	m²×		×			
SOLAR & TRANS GAIN—WALLS & ROOF				227	148	193
Wall (SW)	5.8 m²×	18.6	× 2.1			
	m²×		×			
	m²×		×			
	m²×		×			
Roof—Sun	85.25 m²×	26.2	× 1.1	2457	1988	2251
Roof—Shaded	m²×		×			
TRANS. GAIN—EXCEPT WALLS & ROOF						
Glass	4.2 m²×	17.7	× 5.1	380	380	390
Ceiling	16.25 m²×	8.85	× 1.4	202	202	207
Floor	m²×		×			
Partition (1)	30.15 m²×	8.85	× 1.8	481	481	494
(2)	33.2 m²×	8.85	× 2.5	735	735	756
DOOR	5.4 m²×	8.85	× 1.6	77	77	79
Infiltration	CMH×	deg×	0.29			
INTERNAL HEAT						
People		People×				
Kw	Kw×	×	860			
Lights	101.5×20	W×	1.08	2193	2193	2193
Appliances Etc.						
Credit for Thermal Storage	m²×	deg×		(−)	(−)	
			Sub Total			
Safety Factor			%			
Room Sensible Heat Sub Total				7239	6707	7096
Supply Duct Heat Gain	+ Supply Duct Leak Loss	+ Fan HP	=10%	724	671	710
Bypass Outside Air	CMH×	deg×	BF×0.29			
EFFECTIVE ROOM SENSIBLE HEAT				7963	7378	7806
ROOM LATENT HEAT						
Infiltration	CMH×	g/kg×	0.72			
People		People×				
Steam		kg/h×	540			
Appliances Etc.						
Vapor Trans.						
			Sub Total			
Safety Factor			%			
Room Latent Heat Sub Total						
Supply Duct Leakage Loss			%			
Bypass Outside Air	CMH×	g/kg×	BF×0.72			
EFFECTIVE ROOM LATENT HEAT						
EFFECTIVE ROOM TOTAL HEAT				7963	7378	7806
OUTSIDE AIR HEAT						
Sensible:	CMH×	deg×(1− BF)×0.29				
Latent:	CMH×	g/kg×(1− BF)×0.72				
Grand Total Heat Sub Total						
Return Duct Heat Gain + Return Duct Leak Gain	− Pump H.P	− Pipe Gain	= %			
(U.S.R.T) GRAND TOTAL HEAT						

Estimate For: AM/PM — Peak Load: AM/PM4

Hours of Operation Hour (~)

Outside Design Conditions °CDB °CWB %RH

Conditions	DB °C	WB °C	%RH	DP °C	g/kg
Outside	41.7	28.6	38		18.8
Room	24.0	17.1	50		9.4
Difference	17.7	×××	×××	×××	9.4

BLIND (NON-EXISTENCE (OUTSIDE, INSIDE) L. M. D
GLASS ORDINARY. THICK. ABSORBENT. %. DOUBLE
COLOR LIGHT. MEDIUM. DARK.
WEIGHT kg/m² (FLOOR) kg/m² (WALL)
INTERNAL HEAT W/m² m²/PEOPLE

INFILTRATION

Swinging
Revolving Doors People× CMH/PER.
Open Doors Doors× CMH/DOOR
Exhaust Air
Crack m× CMH/m
Infiltration CMH

VENTILATION

People× CMH/PER.
m²× CMH/m²
Ventilation CMH

SENSIBLE HEAT FACTOR

$$E.S.H.F = \frac{7966\ (ERSH)}{7966\ (ERTH)} = 1.0$$

DEHUMIDIFIED AIR

Apparatus Dewpoint 12.5 °C

$$\frac{7966\ (ERSH)}{(24\ RM - 12.5\ ADP)(1 - 0.1\ BF)\times 0.29} = \quad CMH$$

NOTES

$SR = 2.5\times32.5 + 2.0\times2.0 + 6.5\times2.5 = 101.5$

GLASS (SW) : $1.5\times2.8 = 4.2$

WALL (SW) : $2.5\times4.0 - 4.2 = 5.8$

PARTITION

(1) : $13.5\times2.5 - 3.6 = 30.15$

(2) : $14.0\times2.5 - 1.8 = 33.2$

DOOR : $0.9\times2.0\times3 = 5.4$

ROOF : $SR - 2.5\times6.5 = 85.25$

CEILING : $2.5\times6.5 = 16.25$

FORM E-20E

1037

8.5 設備負荷

5. EQUIPMENT LOAD

5 - 1 PAC - 1

(1) CONDITIONS

	D.B	W.B	ENTHALPY
ROOM :	24.0 °C	17.1 °C	11.5 Kcal/KG
OUTSIDE :	42.2 °C	28.6 °C	22.0 Kcal/KG

R S. H : 119.476 Kcal/H

S. H. F : 0.94

DEHUMIDIFIED AIR : 39.900 m^3/H

OUT AIR : 4.230 m^3/H

RETURN AIR : 35670 m^3/H

(2) REQUIRED COOLING CAPACITY

$$\text{MIX POINT} = \frac{4230\ m^3/H \times 22.0\ Kcal/Kg + 35670\ m^3/H \times 11.5\ Kcal/Kg}{39.900\ m^3/H}$$

$= 12.6$ Kcal/kg

$\therefore$ [$39.900\ m^3/H \times 1.2\ Kg/m^3 \times (12.6 - 8.5)$ kcal/kg $\times$ $(1 - 0.1)$ BF $\times 1.05$

$= 185.000$ Kcal/H.

⊙ PEAK LOAD (PM. 5:00)

E.R.T. H : 125.721 Kcal/H ....①

OUT SIDE AIR HEAT : $4.230\ m^3/H \times 16.5 \times (1-0.1) \times 0.29 = 18.217$ Kcal/H ②

$4.230 \times 9.5 \times (1-0.1) \times 0.72 = 26040$ Kcal/H ③

TOTAL ① + ② + ③ $= (125.721 + 18217 + 26040) \times 1.05 = 179.000$ Kcal/H

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PSYCHROMETRIC CHART

ZONE NAME :

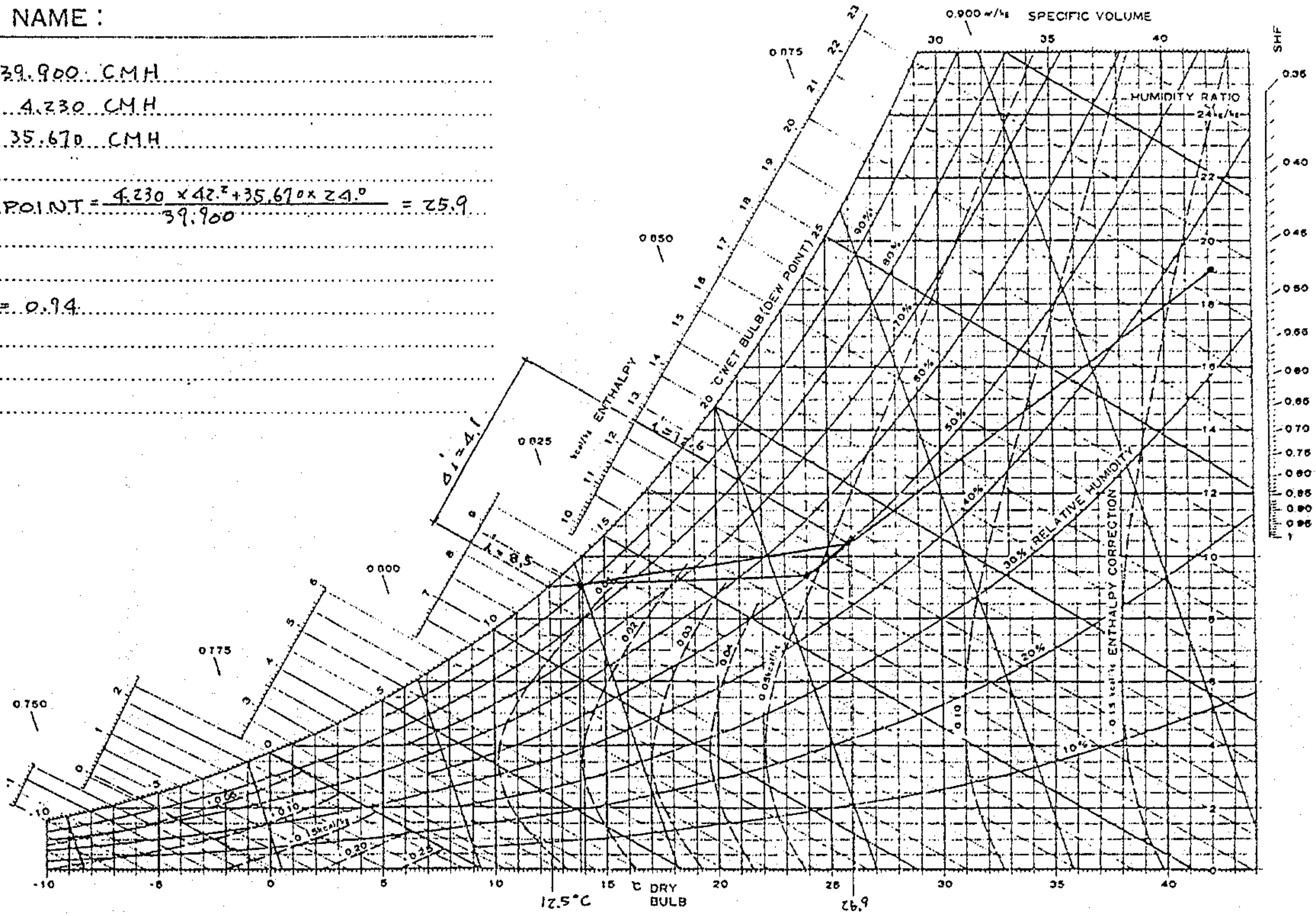
SA = 39.900 CMH

OA = 4.230 CMH

RA = 35.670 CMH

$$\text{MIX POINT} = \frac{4.230 \times 42.^{z} + 35.670 \times 24.^{0}}{39.900} = 25.9$$

SHF = 0.94



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5 - 2 PAC - 2

(1) CONDITIONS

		D.B	W.B	ENTHALPY
ROOM	:	24.0 °C	17.1 °C	11.5 Kcal/Kg
OUTSIDE	:	42.2 °C	28.6 °C	22.0 Kcal/Kg
R.S.H	:	60.067 Kcal/H		
S.H.F	:	0.95		

DEHUMIDIFIED AIR : 20.050 m^3/H

OUT AIR : 1.200 m^3/H

RETURN AIR : 18.850 m^3/H

(2) REQUIRED COOLING CAPACITY

$$\text{MIX POINT} = \frac{1200\,m^3/H \times 22.0\,Kcal/Kg + 18.850\,m^3/H \times 11.5\,Kcal/Kg}{20050\,m^3/H}$$

$$= 12.1\ Kcal/Kg$$

$$\therefore \left[\ 20050\,m^3/H \times 1.2\,Kg/m^3 \times (12.1 - 8.5)\ Kcal/Kg \times (1 - 0.1)_{BF} \times 1.05\right.$$

$$= 82.000\ Kcal/H$$

⊙ PEAK LOAD CPM

E.R.T.H : 62.391 Kcal/H ... ①
OUT SIDE AIR HEAT : $1200\,m^3/H \times 18.2 \times (1-0.1) \times 0.29 = 5.701$ Kcal/H ... ②
: $1200 \times 9.6 \times (1-0.1) \times 0.72 = 7.465$ Kcal/H ... ③

TOTAL = ① + ② + ③ = (62391 + 5701 + 7465) × 1.05 = 80.000 Kcal/H

PSYCHROMETRIC CHART

ZONE NAME :

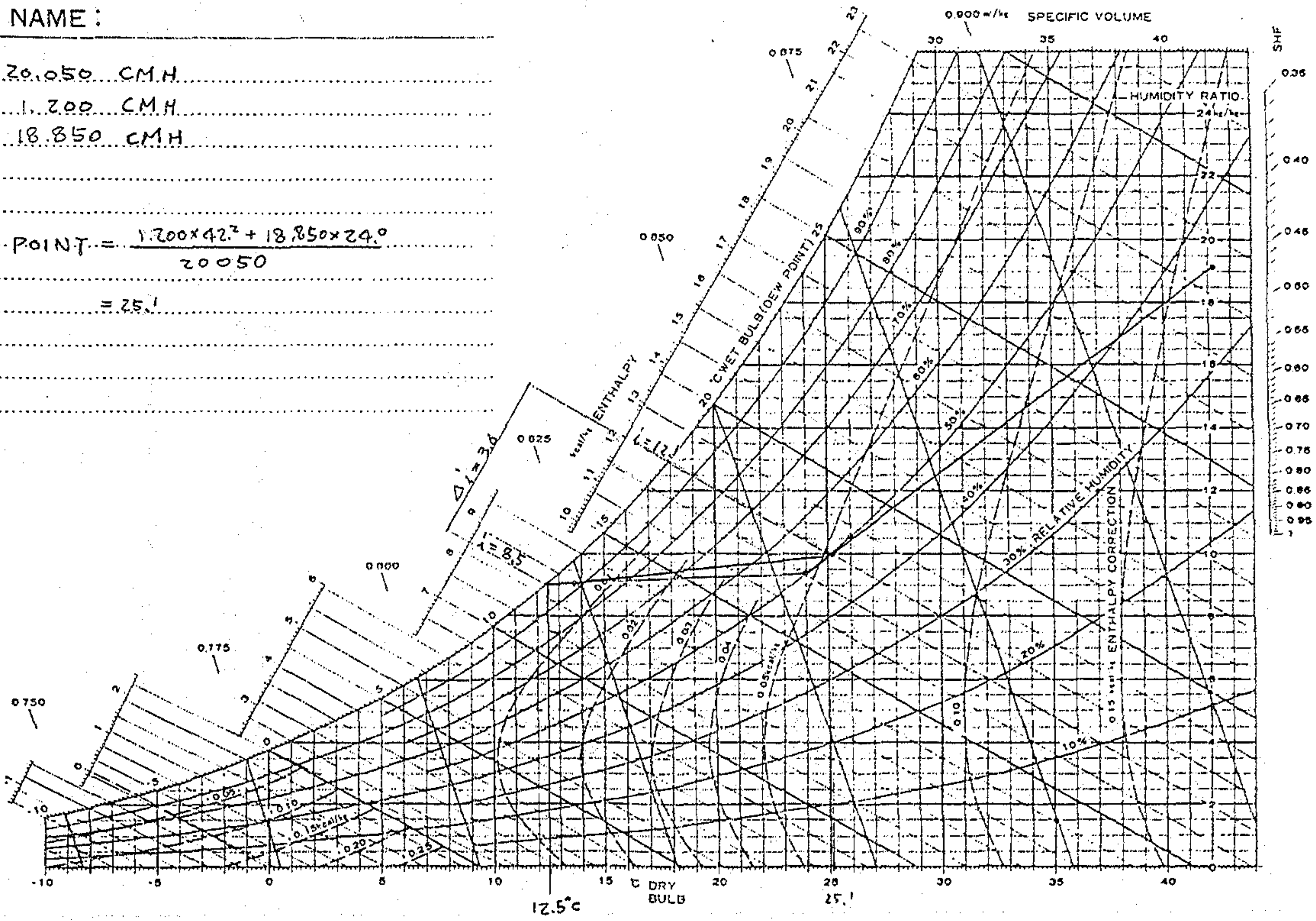
SA = 20.050 CMH

OA = 1.200 CMH

RA = 18.850 CMH

MIX POINT = $\frac{1.200 \times 42.^{\circ} + 18.850 \times 24.^{\circ}}{20050}$

= 25.1



6. SELECTION OF COOING EQUIPMENT

6-1 EQUIPMENT　PAC-1　x 1ea

AIR-COOLED PACKAGED AIR CONDITIONER

AIR FLOW RATE : 39.900 m3/H (665 m3/min)

COOLING LOAD (T.H.R) : 179.000 KCAL/H

(SHC) : 119.476

EXTERNAL STATIC PRES. : 70 mmAq

AIR INLET : 25.9°C DB, 18.4°C WB, 12.6 Kcal/Kg

OUTLET 13.8°C DB, 13.2°C WB, 8.9 Kcal/Kg

CONDENSING TEMPERATURE : 50° DB

TEMPERATURE DIFFERENCE : 15°C

TYPE	: FLOOR (DUCT TYPE)
AIR FLOW RATE	: 39.900 m³/H
COMPRESSOR (3ea)	: 83.5 Kw (INPUT)
FAN MOTOR	: 18.5 Kw (IN), 0.75 Kw x 3 x 3 (OUT)
POWER	: Ø3-380 V, 50Hz
TAPPING SIZE	: (1-3/8" + 7/8") x 3, DRAIN 40 A
DIMENSION (INDOOR)	: 3.700 x 1.600 x 2130 H (mm)
(OUTDOOR)	2.922 x 1.204 x 1126 H x 3
WEIGHT	: (IN) 2.660 Kg, (OUT) 410 Kg x 3

MODEL INDOOR UNIT : 50BM 100 x 1 ea (CARRIER)

OUT DOOR UNIT : 09 DC 024 x 3 ea

$SHC' = 151.000 + 665 \times 17.4 \times (1-0.17) \times (24-27) = 122.000$ kal/H

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6-2 EQUIPMENT PAC-2 × 1ea

AIR-COOLED PACKAGED AIR CONDITIONER

AIR FLOW RATE : 20050 m3/H (345 m3/min)

COOLING LOAD (T.H.R) : 80.000 KCAL/H

(S.H.C) : 60.067 Kcal/H

EXTERNAL STATIC PRES. : 65 mmAq

AIR INLET : 25.1 °C DB , 18.1 °C WB , 12.1 Kcal/Kg

OUTLET : 13.8 °C DB , 13.2 °C WB , 8.9 Kcal/Kg

CONDENSING TEMPERATURE : 50° DB

TEMPERATURE DIFFERENCE : 15° C

TYPE	: FLOOR (DUCT TYPE)
AIR FLOW RATE	: 20.050 m³/H
COMPRESSOR (2ea)	: 45.0 Kw (INPUT)
FAN MOTOR	: 7.5 Kw (IN) , 0.3 kW × 2 × 2 (OUT)
POWER	: Ø3-380 V, 50Hz
TAPPING SIZE	: (1-1/8" + 1-3/8") × 2 DRAIN 40 A
DIMENSION (INDOOR)	: 2.600 × 1.600 × 1.900 H (mm)
(OUTDOOR)	1.900 × 1.118 × 1.028 H × 2
WEIGHT	: (IN) 1.550 Kg (OUT) 180 Kg × 2

MODEL INDOOR UNIT : 50BM 054 × 1ea (CARRIER)

OUTDOOR UNIT : 09DE012 × 2ea.

$$SHC' = 79.000 + 345 \times 17.4 \times (1-0.2) \times (24-27) = 64.600 \text{ Kcal/H}$$

1045

8．7　換　気

7. VENTILATION SYSTEM

7-1 ESTIMATE OF VENTILATION AIR VOLUME

ADMINISTRATION BUILDING (1)

FLOOR	ROOM NAME	AREA (m^2)	VOL. (m^3)	AIR CHANGE (T/Hr)	AIR FLOW (m^3/Hr)	EXHAUST AIR (m^3/Hr)	SUPPLY AIR (m^3/Hr)	
GROUND FLOOR	(G04) MACHINE SHOP	310.	1.488	10	14.880	15.000	15.000	OF-1×4 (I) PF-1×4
	(G05) WELDING ROOM	22.8	109.4	5	547	550	550	OF-3 (I) PF-5
	(G06) TOOL & SPARE PARTS STORAGE ROOM	35.0	168.0	5	840	840	DG: 840	(III) PF-4
	(G07) AIR CONDITIONING MACHINE ROOM	84.5	405.6	5	2028	2100	2100	OF-2 (I) PF-2
	(G08) ELECTRIC ROOM	21.1	101.3	20	2026	2100	2100	OF-2 (I) PF-2
	(G09) LAVATORY	18.4	46	10	460	460 *	–	(III) VF-4
	SUB TOTAL					21.050	20590	SA: 1660 RA: 1200 OA: 460
FIRST FLOOR	(F15) LAVATORY (MALE)	27.0	67.5	10	675	680 *	2670 –	(III) VF-2
	(F16) LAVATORY (FEMALE)	9.0	22.5	10	225	230 *	–	(III) VF-6
	(F18b) LAVATORY	6.8	17.0	10	170	170 *	–	(III) VF-9
	(F14b) SHOWER BOOTH	3.2	8	10	80	80	–	(III) VF-11
	(F14a) SHOWER BOOTH	3.0	7.5	10	75	80	–	(III) VF-11
	(F12) DRESSING RM.	7.0	17.5	10	175	180 *	–	(III) VF-8
	(F18a) LAVATORY	3.0	7.5	10	75	80 *	–	(III) VF-11
	(F13) KITCHENETTE	6.0	15.0	10	150	150	–	(III) VF-10
	(F17) LAVATORY.	7.0	17.5	10	175	180 *	–	(III) VF-8
	(F06) PANTRY	9.0	22.5	10	225	250 *	–	(III) PF-6
	(F08) BATTERY ROOM	16.0	60.8	10	608	610	610	OF-4 (I) VF-3
	~~(F05)~~ KITCHEN	33.3	83.25	10	833	900 *	700 200 –	RF-1 (III) VF-7
								(13380+5400)
	SUB TOTAL					3.590		SA: 18.780 RA: 16.110 OA: 2670

(2270+400)

9046

ESTIMATE OF VENTILATION AIR VOLUME

ADMINISTRATION BUILDING (2)

FLOOR	ROOM NAME	AREA (m^2)	VOL. (m^3)	AIR CHANGE (T/Hr)	AIR FLOW (m^3/Hr)	EXHAUST AIR (m^3/Hr)	SUPPLY AIR (m^3/Hr)	
SECOND FLOOR	(S09) LAVATORY (MALE)	27.0	67.5	10	675	680 *	1250 —	(III) VF-2
	(S10) LAVATORY (FEMALE)	9.0	22.5	10	225	230 *	—	(III) VF-6
	(S11b) LAVATORY	6.8	17.0	10	170	170 *	—	(III) VF-9
	(S12b) SHOWER BOOTH	3.2	8	10	80	80	—	(III) VF-11
	(S11a) LAVATORY	6.8	17.0	10	170	170 *	—	(III) VF-9
	(S12a) SHOWER BOOTH	3.2	8	10	80	80	—	(III) VF-11
	SUB TOTAL					1.410	—	SA = 16.030 RA = 14.780 OA = 1.250
THIRD FLOOR	(T07) LAVATORY (MALE)	27.0	67.5	10	675	⇒ 750 *	1050 —	(III) VF-1
	(T08) LAVATORY (FEMALE)	9.0	22.5	10	225	⇒ 300 *	—	(III) VF-5
	SUB TOTAL					1050		SA = 23.480 RA = 22430 OA = 1050
								TSA : 59.950 TRA : 54520 TEA/OA : 5430
ROOF	(R01) ELEVATOR MACHINE ROOM	27.7	85.9	20	1.718	1800		(III) PF-3
	G. TOTAL							

7-2. SERECTION OF VENTILATION EQUIPMENT

V - 1. MACHINE SHOP (GROUND FLOOR)

MACHINE NO PF-1 (=OF-1 x 4 ea)

TYPE OF VENTILATOR	:	PROPELLER x 4 ea
AIR FLOW RATE	:	3750 m^3/Hr ϕ500 x 5mmAg
FAN MOTOR	:	0.4 KW or w
POWER	:	~~1ϕ 220v~~ / 3ϕ 380 v (50/~~60~~ Hz)
SIZE	:	620 x 620 x 332 (mm)
ACCESSORY	:	SUS WEATHER COVER, SHUTTER

V - 2 ELECTRIC ROOM. (GROUND FLOOR)

MACHINE NO PF-2 (=OF-2 x 1 ea)

TYPE OF VENTILATOR	:	PROPELLER x 1 ea
AIR FLOW RATE	:	2.100 m^3/Hr ϕ400 x 5mmAg
FAN MOTOR	:	0.1 KW or w
POWER	:	~~1ϕ 220v~~ / 3ϕ 380 v (50/~~60~~ Hz)
SIZE	:	520 x 520 x 268 (mm)
ACCESSORY	:	SUS. WEATHER COVER, SHUTTER

V - 3 AIR CONDITONING MACHINE ROOM (GROUND FLOOR)

MACHINE NO PF-2, (=OF-2 x 1 ea)

TYPE OF VENTILATOR	:	PROPELLER x 1 ea
AIR FLOW RATE	:	2.100 m^3/Hr ϕ400 x 5mmAg
FAN MOTOR	:	0.1 KW or w
POWER	:	~~1ϕ 220v~~ / 3ϕ 380 V (50/~~60~~ Hz)
SIZE	:	520 x 520 x 268 (mm)
ACCESSORY	:	SUS WEATHER COVER, SHUTTER

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V - 4 WELDING ROOM (GROUND FLOOR)

MACHINE NO PF-5 (=OF-3 x 1ea)		
TYPE OF VENTILATOR	:	PROPELLER x 1 ea
AIR FLOW RATE	:	550 m^3/Hr 250$^\phi$ x 5mmAq
FAN MOTOR	:	0.025 KW or W
POWER	:	~~1φ 220v~~ / 3φ 380 v (50/~~60~~ Hz)
SIZE	:	370 x 370 x 214 (mm)
ACCESSORY	:	SUS WEATHER COVER, SHUTTER

V - 5. TOOL & SPARE PARTS STORAGE ROOM (GROUND FLOOR)

MACHINE NO PF-4		
TYPE OF VENTILATOR	:	PROPELLER x 1 ea
AIR FLOW RATE	:	840 m^3/Hr 300$^\phi$ x 5 mmAq
FAN MOTOR	:	0.050 KW or W
POWER	:	~~1φ 220v~~ / 3φ 380 v (50/~~60~~ Hz)
SIZE	:	420 x 420 x 247 (mm)
ACCESSORY	:	SUS WEATHER COVER, SHUTTER

V - 6. LAVATORY (GROUND FLOOR)

MACHINE NO VF - 4		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	460 m^3/Hr x 6 mmAq
FAN MOTOR	:	~~KW~~ or 62 W
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	345 x 345 x 243H (mm)
ACCESSORY	:	150$^\phi$ VENT CAP

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V - 7 LAVATORY (MALE) (FIRST, SECOND FLOOR)

MACHINE NO VF - 2		
TYPE OF VENTILATOR	:	AXIAL FAN x 2 ea
AIR FLOW RATE	:	680 m^3/Hr x 8^{mmAq}
FAN MOTOR	:	~~KW~~ or 40 W
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	375^{ϕ} x (224^{ϕ}) x 320^{L} (mm)
ACCESSORY	:	

V - 8 LAVATORY (MALE) (THIRD FLOOR)

MACHINE NO VF - 1		
TYPE OF VENTILATOR	:	AXIAL FAN x 1 ea
AIR FLOW RATE	:	750 m^3/Hr x 8^{mmAq}
FAN MOTOR	:	~~KW~~ or 40 W
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	375^{ϕ} x (224^{ϕ}) x 320^{L} (mm)
ACCESSORY	:	

V - 9 BATTERY ROOM (FIRST FLOOR)

MACHINE NO VF - 3		(OF - 4 x 1 ea)
TYPE OF VENTILATOR	:	AXIAL FAN x 1 ea
AIR FLOW RATE	:	610 m^3/Hr x 8^{mmAq}
FAN MOTOR	:	KW or 40 W
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	375^{ϕ} x (224^{ϕ}) x 320^{L} (mm)
ACCESSORY	:	

V - 10
LAVATORY (FEMALE) (FIRST, SECOND FLOOR)

MACHINE NO VF-6		
TYPE OF VENTILATOR	:	CEILING x 2 ea
AIR FLOW RATE	:	230 m^3/Hr x 7 mmAq
FAN MOTOR	:	~~KW~~ or 35 w
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	308 x 308 x 243 H (mm)
ACCESSORY	:	150φ VENT CAP

V - 11
LAVATORY (FEMALE) (THERD FLOOR)

MACHINE NO VF-5		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	300 m^3/Hr x 8 mmAq
FAN MOTOR	:	~~KW~~ or 46 w
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	345 x 345 x 243 H (mm)
ACCESSORY	:	150φ VENT CAP

V - 12
LAVATORY (FIRST, SECOND FLOOR) <F18b> · <S11b,a>

MACHINE NO VF-9		
TYPE OF VENTILATOR	:	CEILING x 3 ea
AIR FLOW RATE	:	170 m^3/Hr x 8 mmAq
FAN MOTOR	:	~~KW~~ or 35 w
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	308 x 308 x 243 H (mm)
ACCESSORY	:	150φ VENT CAP

V - 13
SHOWER BOOTH (FIRST, SECOND FLOOR) <F14a, b, S12a, b>

MACHINE NO VF - 11		
TYPE OF VENTILATOR	:	CEILING x 4 ea
AIR FLOW RATE	:	80 m^3/Hr x 8 mmAq
FAN MOTOR	:	~~KW~~ or 13 W
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	303 x 303 x 204H (mm)
ACCESSORY	:	100φ VENT CAP

V - 14
DRESSING ROOM (FIRST FLOOR)

MACHINE NO VF - 8		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	180 m^3/Hr x 8 mmAq
FAN MOTOR	:	~~KW~~ or 35 W
POWER	:	1φ 220v / ~~3φ 460v~~ (50/~~60~~ Hz)
SIZE	:	308 x 308 x 243H (mm)
ACCESSORY	:	150φ VENT CAP

V - 15.
LAVATORY (FIRST FLOOR) <F18a>

MACHINE NO VF - 11		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	80 m^3/Hr x 8 mmAq
FAN MOTOR	:	KW or 13 W
POWER	:	1φ 220v / ~~3φ 460v~~ (50/60 Hz)
SIZE	:	303 x 303 x 204H (mm)
ACCESSORY	:	100φ VENT CAP

V - 16
KITCHENETE

MACHINE NO VF-10		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	150 m^3/Hr x 6 mmAq
FAN MOTOR	:	~~KW~~ or 25 w
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	303 x 303 x 204H (mm)
ACCESSORY	:	100ϕ VENT CAP

V - 17
LAVATORY (FIRST FLOOR) <F 17>

MACHINE NO VF-8		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	180 m^3/Hr x 5 mmAq
FAN MOTOR	:	~~KW~~ or 35 w
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/60 Hz)
SIZE	:	308 x 308 x 243H (mm)
ACCESSORY	:	150ϕ VENT CAP

V - 18
PANTRY (FIRST FLOOR)

MACHINE NO PF-6		
TYPE OF VENTILATOR	:	PROPELLER x 1 ea.
AIR FLOW RATE	:	250 m^3/Hr 200ϕ
FAN MOTOR	:	~~KW~~ or 18 w
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	280 x 280 x 152D (mm)
ACCESSORY	:	SUS. WEATHER COVER, SHUTTER

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V - 19

KITCHEN

MACHINE NO RF-1		
TYPE OF VENTILATOR	:	RANGE HOOD FAN x 1 ea
AIR FLOW RATE	:	700 m^3/Hr x 3 mmAq
FAN MOTOR	:	~~KW~~ or 70 w
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	600 x x 580H (mm)
ACCESSORY	:	SUS WEATHER COVER

V - 20

KITCHEN

MACHINE NO VF-7		
TYPE OF VENTILATOR	:	CEILING x 1 ea
AIR FLOW RATE	:	200 m^3/Hr x 8 mmAq
FAN MOTOR	:	~~KW~~ or 35 w
POWER	:	1ϕ 220v / ~~3ϕ 460v~~ (50/~~60~~ Hz)
SIZE	:	308 x 308 x 243H (mm)
ACCESSORY	:	150ϕ VENT CAP

V - 21

ELEVATOR MACHINE ROOM

MACHINE NO PF-3		
TYPE OF VENTILATOR	:	PROPELLER x 1 ea
AIR FLOW RATE	:	1800 m^3/Hr ϕ400 x 5 mmAq
FAN MOTOR	:	0.1 KW or w
POWER	:	~~1ϕ 220v /~~ 3ϕ 380v (50/60 Hz)
SIZE	:	520 x 520 x 268 (mm)
ACCESSORY	:	SUS WEATHER COVER, SHUTTER

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V - 22

RETURN FAN (G. FLOOR AIR CONDITIONING MACHINE RM.)

MACHINE NO	RAF - 1	SS # 7
TYPE OF VENTILATOR	:	CENTIFUGAL MULTI - BANE x 1 ea
AIR FLOW RATE	:	54.520 m^3/Hr x 25 mmAq
FAN MOTOR	:	15 KW or w
POWER	:	~~1ϕ 220v~~ / 3ϕ 380 v (50/~~60~~ Hz)
SIZE	:	2500L x 900W x 2070H (mm)
ACCESSORY	:	

V -

MACHINE NO		
TYPE OF VENTILATOR	:	x ea
AIR FLOW RATE	:	m^3/Hr
FAN MOTOR	:	KW or w
POWER	:	1ϕ 220v / 3ϕ v (50/60 Hz)
SIZE	:	x x (mm)
ACCESSORY	:	

V -

MACHINE NO		
TYPE OF VENTILATOR	:	x ea
AIR FLOW RATE	:	m^3/Hr
FAN MOTOR	:	KW or w
POWER	:	1ϕ 220v / 3ϕ v (50/60 Hz)
SIZE	:	x x (mm)
ACCESSORY	:	

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ＣＶ－１　土木設計条件

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CV-1　土木設計条件

1. 設計条件

1) 潮　位

a) The Highest High Water Level (The Highest Astronomical Tide is adopted as design H.H.W.L)

H.H.W.L = E.L + 3.23 m

b) Mean Sea Water Level

M.S.L = E.L + 1.64 m

c) The Lowest Low Water Level (The lowest Astronomical Tide is adopted as design L.L.W.L)

L.L.W.L = E.L - 0.43 m

2) 風 荷 重

The design wind loads are indicated in the design concept of architectural/structural section, if necessary.

3) 現地盤高

G.L. = E.L + 4.80 m

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4) 土質条件

The soil physical values shall be determined at the normal cases as follows.

a) The N − Value

The N − Value shall be adopted from the site boring test.

b) The angle of the internal friction ϕ

In the case of sandy soil, the angle of the internal friction ϕ shall be calculated by the following equation.

$$\phi = 15 + \sqrt{15N} \leqq 45^\circ \quad \text{provided that} \quad N > 5$$

2. 設計荷重

1) 鉛直荷重の組合せ. The increment ratio

a)	Long term (D.L + L.L)	1.0
b)	Short term (D.L + L.L + W.L)	1.25
c)	Short term (D.L + S.L)	1.50

Where
D.L : Dead load
L.L : Live load
W.L : Wind load
S.L : Seismic load

2) 地震時荷重 (S.L) L

$F_w = K_h \cdot W$ Where K_h : Seismic coeficient = 0.1
W : Weight of structure included dead load.

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3) 活荷重

a) Truck load

Truck load (T − 20)

The gross weight	:	20 ton
A front wheel weight	:	2 ton
A rear wheel weight	:	8 ton

b) The impact coefficient (i)

$$i = 0.3$$

4) 粘着力C

Cohesion C shall be calculated by the following equation.

$$C = \frac{q_u}{2}$$

q_u : the uniaxial compressive stress

q_u can be obtained from Table 1, if N - values can be measured.

Table 1. Relation of the N values vs consistency q_u of cohesive soil

N value	Consistency of cohesive soil	q_u (kg/cm²)
0 to 1	Very soft	0.25 to below
2 to 4	Soft	0.25 to 0.5
5 to 8	Normal(medium)	0.5 to 1.0
9 to 15	Hard	1.0 to 2.0
16 to 30	Very hard	2.0 to 4.0
30 to above	Consolidated	4.0 to above

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3. 水路水理計算

1) 損失水頭総括表

Table 2. Example of the loss in water channel

Equipment	Loss
Intake	① Loss due to inflow curtain. ② Loss due to friction between intake.
Intake Channel	① Loss due to inflow at intake channel ② Loss due to friction of water channel wall ③ Loss due to water channel's cross sectional change (Gradual contractin and gradual expansion) and bend etc.) ④ Loss due to water channel's accessory machineries and structures.
Screen Pump Pit	① Loss due to inflow at Screen Room ② Loss due to Screens ③ Loss due to inflow at Pump Room ④ Loss due to room wall friction
Discharge Channel	① Loss due to outlet conduit and discharge culvert ② Loss due to the wall friction of channel ③ Loss due to water channel's sectional change (gradual contraction, gradual expansion) ④ Loss due to water channel's accessory (machineries and structures)
Outlet	① Loss due to outlet's exit ② Loss due to the friction of water channel wall ③ Loss due to water channel's sectional change (gradual expansion, etc) ④ Loss due to water channel's necessory structures, such as hiden wier, pier, etc.

2) 粗度係数

表－2の粗度計数は、一般の水路水理計算に使用されている値である。

Table 2. The coefficient of the roughness used for water channel

Wall shape	n	Wall shape	n
Welded steel pipe	0.012	Ordinary concrete with shells stuck	0.02
Good concrete surface such as centrifugal force steel reinforced concerte pipe	0.013	Steel plate	0.02
Ordinary concrete such as cast-in-field concrete	0.015	Other especially rough surface	0.03
Concrete block	0.02		

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4. 許容応力

1) 鉄筋コンクリートの許容応力 (kg/cm²)

Stresses / Concretes		Permanent Stresses: Compression	Shear (1)	Shear (2)	Bond
Concrete for (above) C-400	plain bar	130	5.5	24	10
	Deformed bar		(slab) 11		20
Concrete for C-300	Plain bar	100	5	22	9
	Deformed bar		(slab) 10		18
Concrete for C-240	Plain bar	80	4.5	20	8
	Deformed bar		(slab) 9.0		16
Concrete for C-210	Plain bar	70	4.25	19	7.5
	Deformed bar		(slab) 8.5		15
Concrete for C-180	Plain bar	60	4	18	7
	Deformed bar		(slab) 8		14

*Remarks (1):No calculating with diagonal tention bar.
(2):Calculating with diagonal tention bar.

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2) 鉄筋の許容応力度 (kg/cm²)

Stresses / Materials	Permanent stresses	
	Tension	Compression
SD 30	1,800	1,800
SD 35	1,800	2,000
SD 30 for Pile	1,600	1,800

3) 鋼の許容応力度 (kg/cm²)

	Permanent Stresses		
Type of Steel	Tension	Compression	Shear
SS 41 SM 41	1,400	1,400	800

4) 溶接部の許容応力度 (kg/cm²)

Appli-cation	Stresses	Permanent Stresses			
	Welding Positions	Groove Weld			Fillet
	Materials	Tension	Compress	Shear	Shear
	(SS41,SM41)	1,400	1,400	800	800

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5) コンクリートのヤング率

a) At the case of the displacement calculation

CK(kg/cm²)	180	240	270	300
Ec(kg/cm²)	2.2×10^5	2.5×10^5	2.65×10^5	2.8×10^5

b) At the case of the unit stress calculation

$E_c = 1.4 \times 10^5$ (kg/cm²)

5. 適用基準

1) 日本土木学会

a) Standards for Calculation of Reinforced Concrete Structures

b) Design Standards for Steel Structures

c) Standards for Structural Design of Building Foundations

2) 日本道路協会

Specifications for Highway Bridges

3) 日本港湾協会

Technical Standards for Port and Harbour Facilities

4) 日本建築学会基準

Standard Specification for Concrete

5) 日本工業規格

ＣＶ－２　冷却水路計算要項

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1．開渠取水路

開渠取水路の概要は、図－１，２に示されている。
断面寸法データの根拠が次のように説明されている。

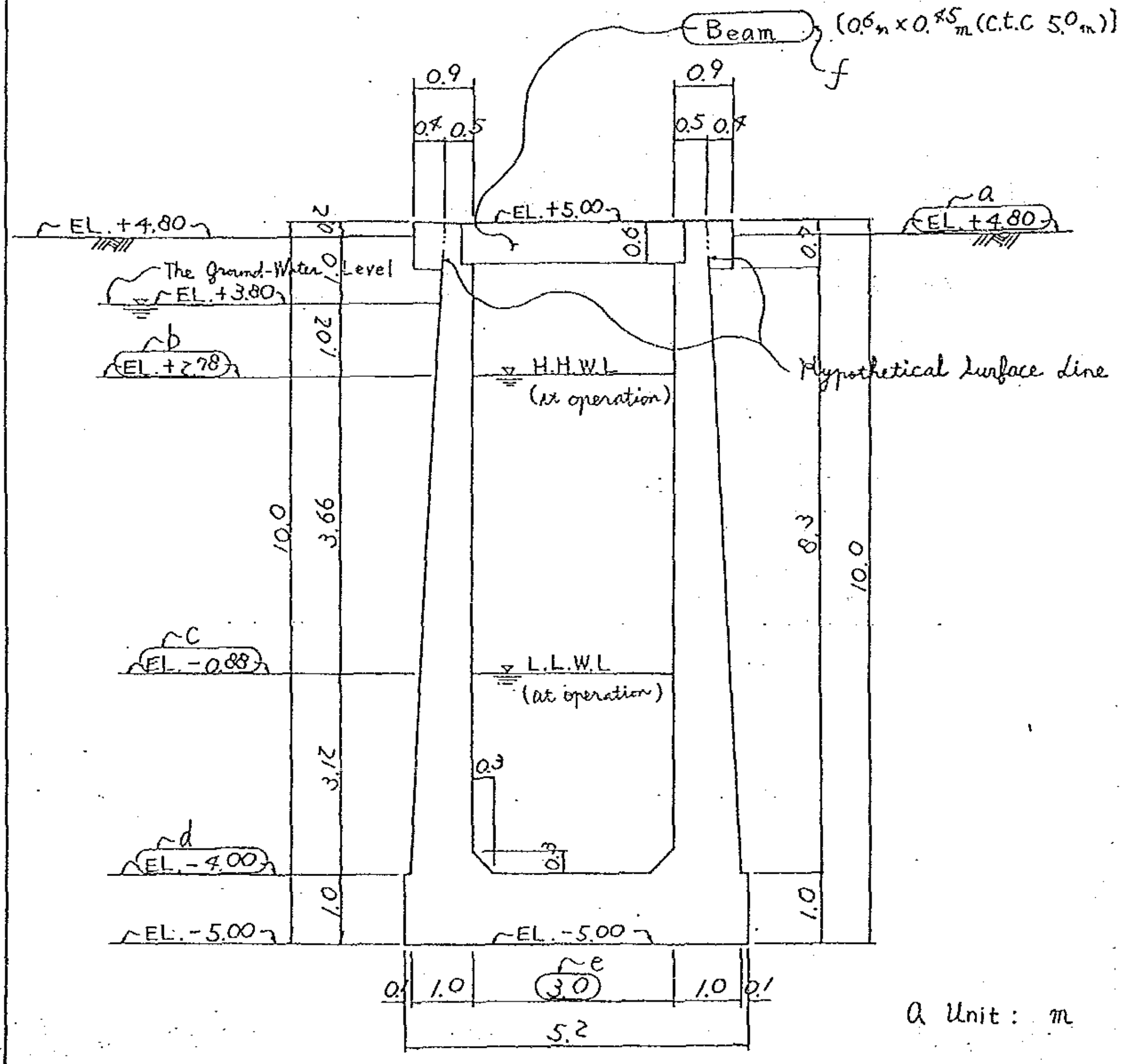

Fig 1. Typical section of Intake Open Channel

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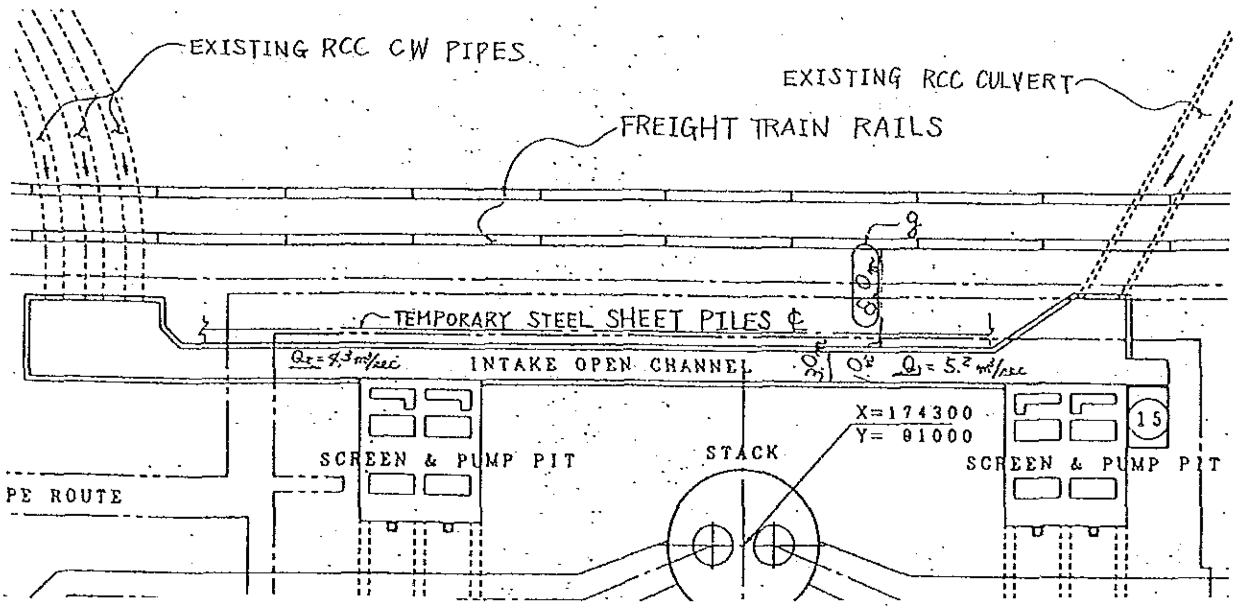

Fig 2. Plan of Intake Open Channel

a．地 盤 高 (EL.＋4.8m)

The ground level was determined in "Civil Design Conditon"(vid.1.3,P1, ENGINEERING SHEET No.EWC-1001), so the site ground shall be leveled at EL.＋4.8m.

b．最高潮位 (EL.＋2.78m)

This level was determined in consideration of the water head loss due to Intake Culvert(vid.3.1).a),P11,ENGINEERING SHEET No.EWC-1003) at the highest high sea water level(EL.＋3.23m), so the calculation is as follows.

↓

(vid.1.1).a,P1,EWC-1001).

[H.H.W.L]		(The head loss due to culvert)	
EL.＋3.23m	−	0.45m	= EL.＋2.78m

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c．最低潮位（EL.－0.88m）

This level was determined in consideration of the water head loss due to Intake Culvert at the lowest low water level(EL.－0.43m).

↓

(vid.1.1).c,EWC-1001)

The Calculation is as follows.

[L.L.W.L]		(The head loss due to Intake Culvert)	
EL.－0.43m	－	0.45m	= EL.－0.88m

d．開渠取水路の床面高さ（EL.－4.0m）

The level of bottom floor was determined in accordance with the bottom floor level of existing Intake Culvert (EL.－1.3feet≒EL.－4.0m) as shown in Fig ?

e．開渠取水路の巾（＝ 3.0m）

The width of Intake Open Channel was determined to limit the water velocity less than V =1.0 m/sec at L.L.W.L.

The calculation is considered for the shells stuck 10cm.

(vid.Fig 4,P10,EWC-1003)

$$V = \frac{Q_1}{A} = \frac{5.2m^3}{(3.0-2\times0.1)\times(3.12-0.1)} = 0.61 \text{ m/sec} < 1.0 \text{ m/sec}$$

f．貨物用レールと仮設鋼板中心線との距離

The distance was determined to avoid the influence area occured by the relaxation of the back ground of retaining wall.

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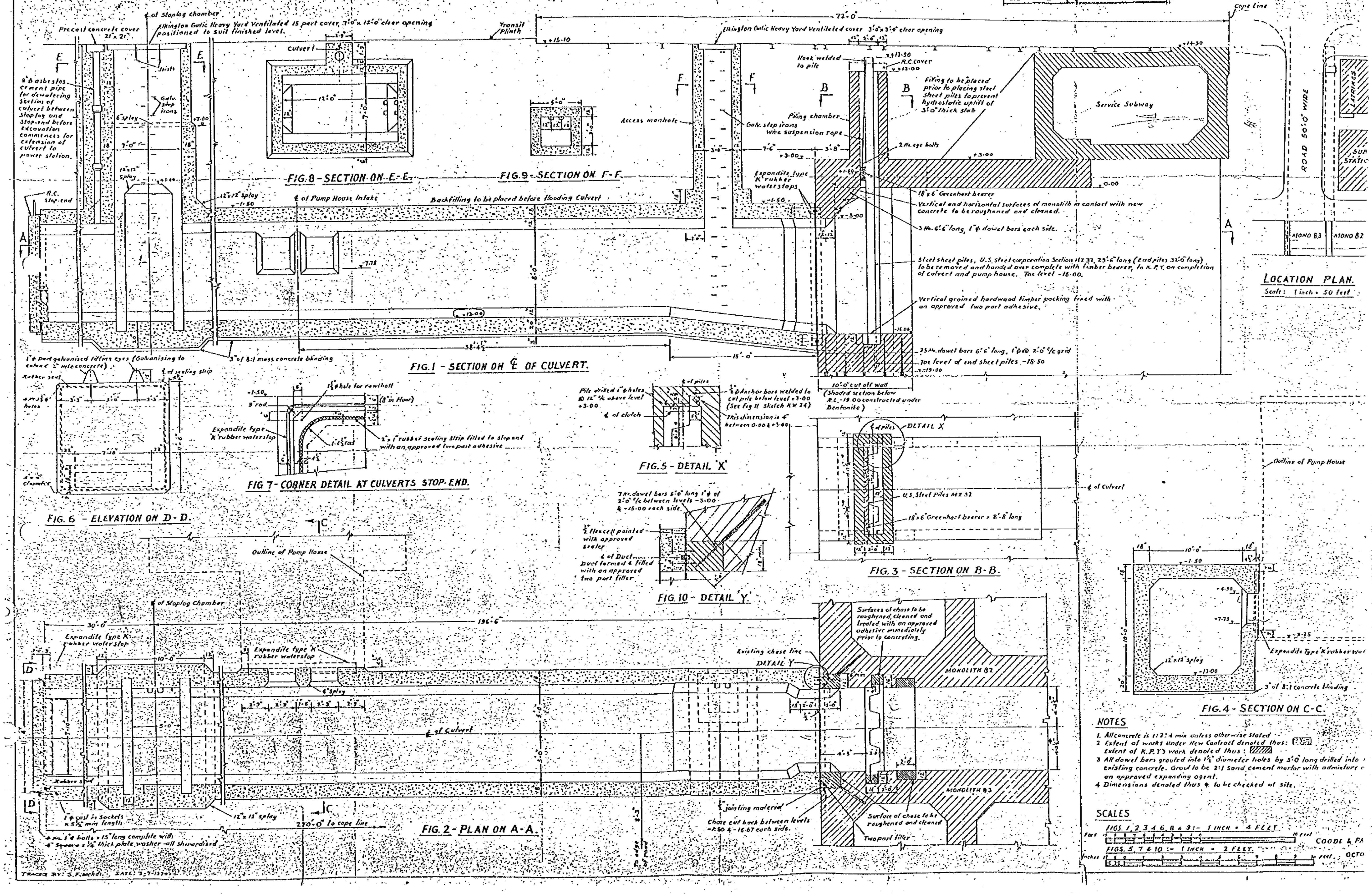
E.N.C's REGISTRATION No WWS-10

Fig 3



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The section of the influence area occured by the relaxation of the back ground is shown in Fig 4.

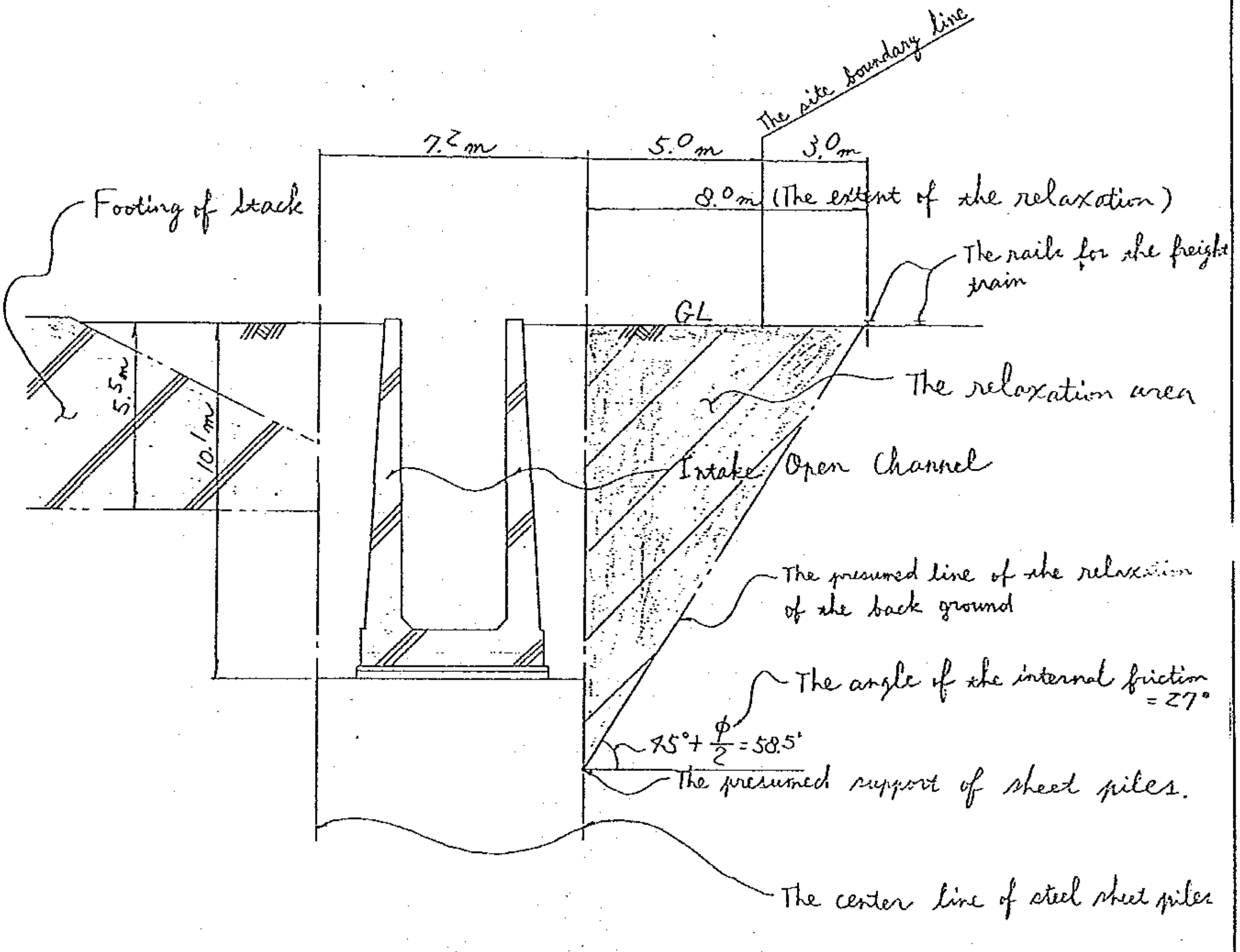

Fig 4. The influence area of the relaxation of the back ground

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2．ポンプピット

ポンプピットの概要は、図－５，６に示されている。

断面寸法データの根拠は、次のように説明される。

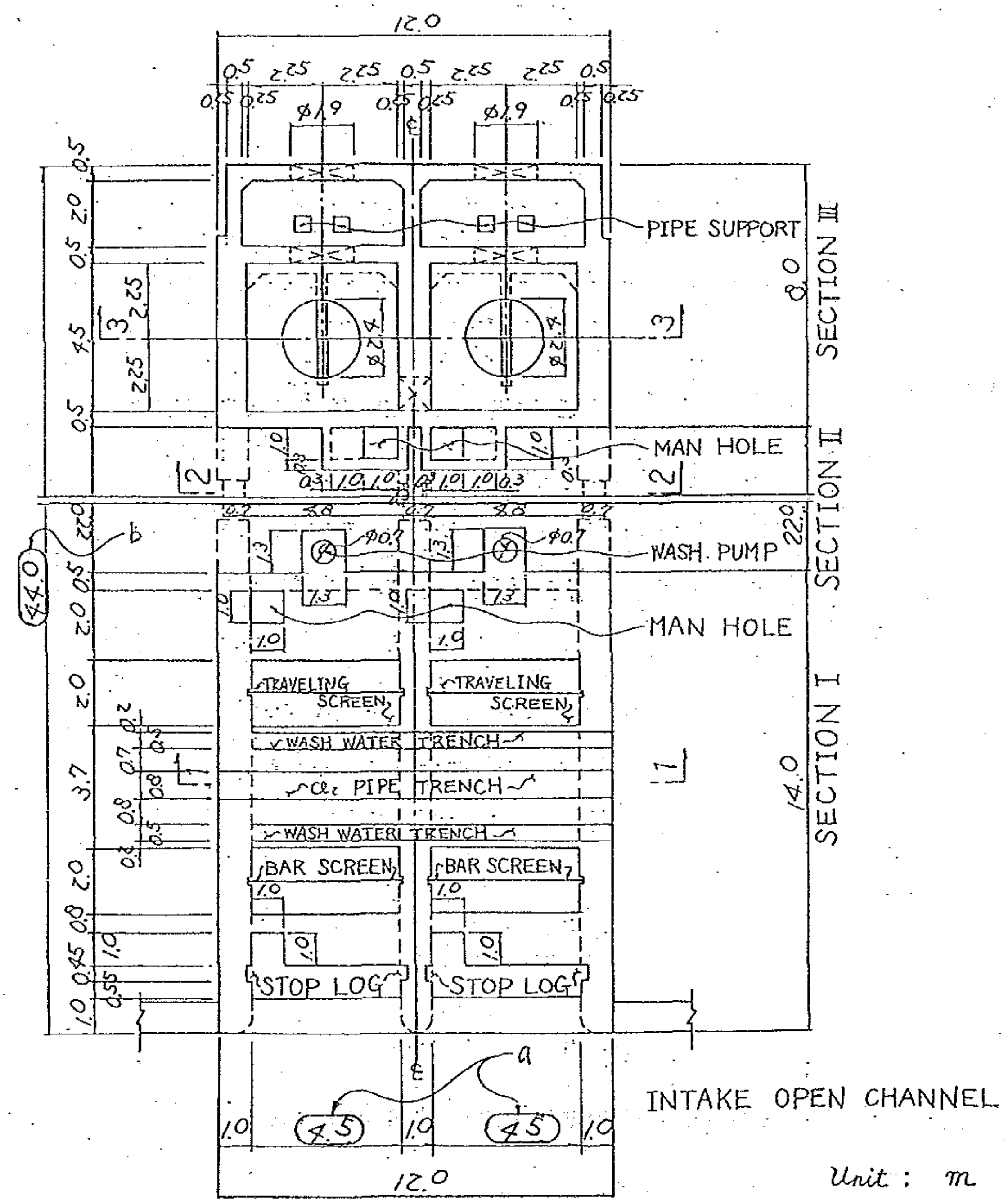
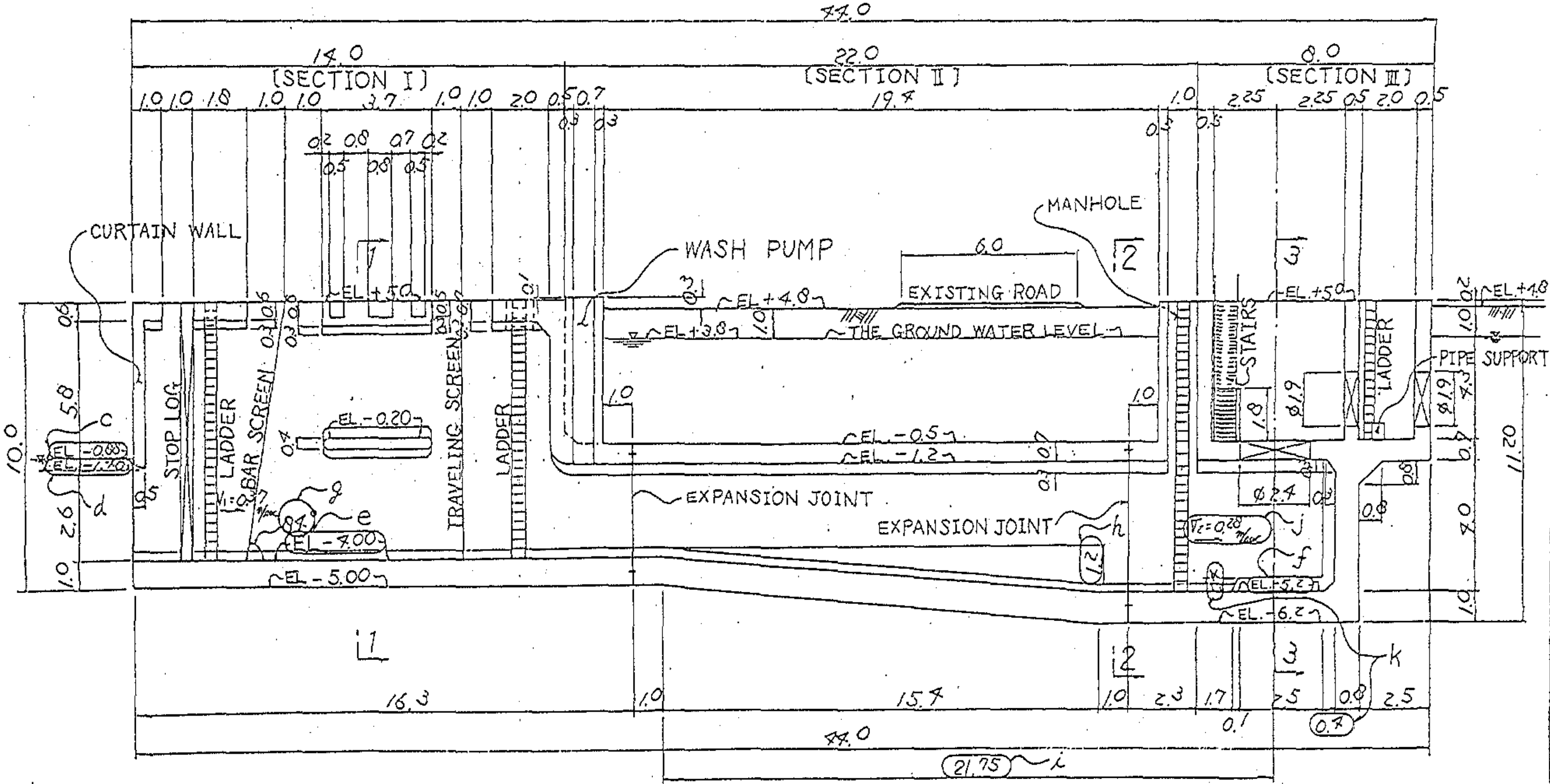


Fig 5. Plan of Pump Pit



Unit: m

Fig 6. Profile of Pump Pit

a．ポンプ室とスクリーン室の内空幅

The internal width of Pump Room was determined by the following relations.

i) by the data from Table 1.

Let the width is B,

$$2.0\ Do \leqq B \leqq 2.5\ Do$$

$$3.6m \leqq B \leqq 4.5m$$

Where Do : the diameter of C.W Pump's bellmouth = 1.8m

ii) by the limit of the approrch velocity

The approach velocity to bar screen V_1 is usually controled by the following relation.

The internal width of Screen Room is determined by the approach velocity to bar screen, then the approach velocity V_1 is restricted by the following relation.

$$V_1 \leqq \underline{0.375\ m/sec}$$

↓

(vid. Table 1)

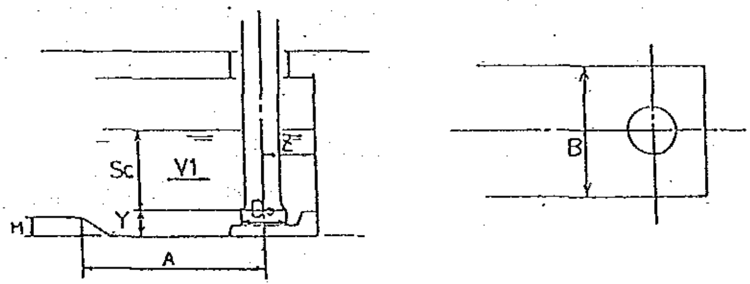
In this design case V_1 is calculated as follows.

$$V_1 = \frac{Q}{A} = \frac{4.75}{4.3 \times 3.02} = 0.37\ m/sec < 0.375\ m/sec$$

According to the above mentioned relation, the internal width was dertermined $B_1 = 4.5m$

Table 1. The compared table with the usual and the recommended dimensional data of Pump Pit

No.	Items	The usual value	The recommended value	Remarks
1	The diameter of Bellmouth :Do		Do=1800mm	
2	The width of Pump Room :B	B=2.0~2.5Do	B =4500mm	
3	The distance between Bellmouth and the bottom floor :Y	B=0.5~0.75Do	Y =900mm	Y = 0.5Do
4	The distance between the center of Pump and the back wall :Z	Z=0.8~1.0Do	Z =1800mm	The preventive wall for vortex was designed.
5	The submarged depth:Sc	Sc≧ 1.5Do	Sc=2700mm	
6	The approach velocity to Pump and Screen :V_2	V_2≦0.375m/sec		In this design case V_2 = 0.28 m/sec
7	The distance between the Center of Pump and the mound :A	A≧6.0Do	A≧10.8m	
8	The height of mound:Hm	Hm≦ 0.8Do	Hm≦1.44m	



The reference drawing

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b．ポンプピットの延長

The length of Pump Pit is determined by the site layout plan.
(vid. DWG No. WGTS-1002)

c．最低潮位（EL.－0.88m）

This water level was the same level as Intake Open Channel.

d．カーテンウォールの下端位置

The lowest side level of curtain wall is calculated as follows.

[L.L.W.L]		(the allowance)		
EL.－0.88m	－	0.52m	＝	EL.－1.40 m

e．スクリーン室の床面高さ

The bottom floor level of Screen Room was determined in accordance with the bottom floor level of Intake Open Channel(vid. Fig 1), accordingly this level was setted up at EL.－4.00m.

f．ポンプ室の床面高さ

The bottom floor level of Pump Room was determined by the height of the back wall of Pump Room, and the height of the back wall of Pump Room H_b was determined by the following relation.

$$H_b = S_c + Y \geqq 1.5D_o = 1.5 \times 1.8 + 0.5 \times 1.8 = \underline{3.6m}$$

accordingly H_b was determined $\underline{H_b = 4.0m}$, so the bottom floor level was calculated as below.

(The lower side level of Pump Room)		[H_b]		
EL. －1.20m	－	4.0m	＝	EL.－5.2m

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g. バスクリーンと床面との取付け設定角度

The setting angle of Bar Screen was determined by the reference of "Design for the Civil Structures of Thermal Powew Plant and Nuclear Power Plant" published by The Society of Electric Power Civil Technology, Japan.(vid.12-10-3,P435)

h. スクリーン室とポンプ室との床面高さの差

This difference in level H_m was determined by the following relation. (vid.Item No. 8 in Table 1)

$$\underline{H_m = 1.2m} \leqq 0.8Do = 0.8 \times 1.8m = 1.44m$$

i. 法面の水平長

The horizontal length of the slope A was determined by the following relation to the distance between the vertical center of Pump and mound. (vid.Item No. 8 in Table 1)

$$\underline{A = 21.75m} \geqq 6.00Do = 10.8m$$

j. ポンプへの接近流速

The approach velocity to Pump V_2 is calculated by the following equation.

$$V_2 = \frac{Q}{A} = \frac{4.5}{4.3 \times 3.8} \fallingdotseq 0.28\ m/sec \leqq \underline{0.375m/sec}$$

(vid.Item No. 6 in Table 1)

k. 渦巻き防止壁の断面寸法データ

The dimensional data of the protection wall for vortex was determined by the reference data from the mechanical design structure.

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ＣＶ－３　水路水理計算

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1．水路水理計算結果

水路水理計算は、循環水ポンプと復水器冷却水路の損失水頭により決定される。
水路水理計算結果は、図－1，図－2に表わされている。

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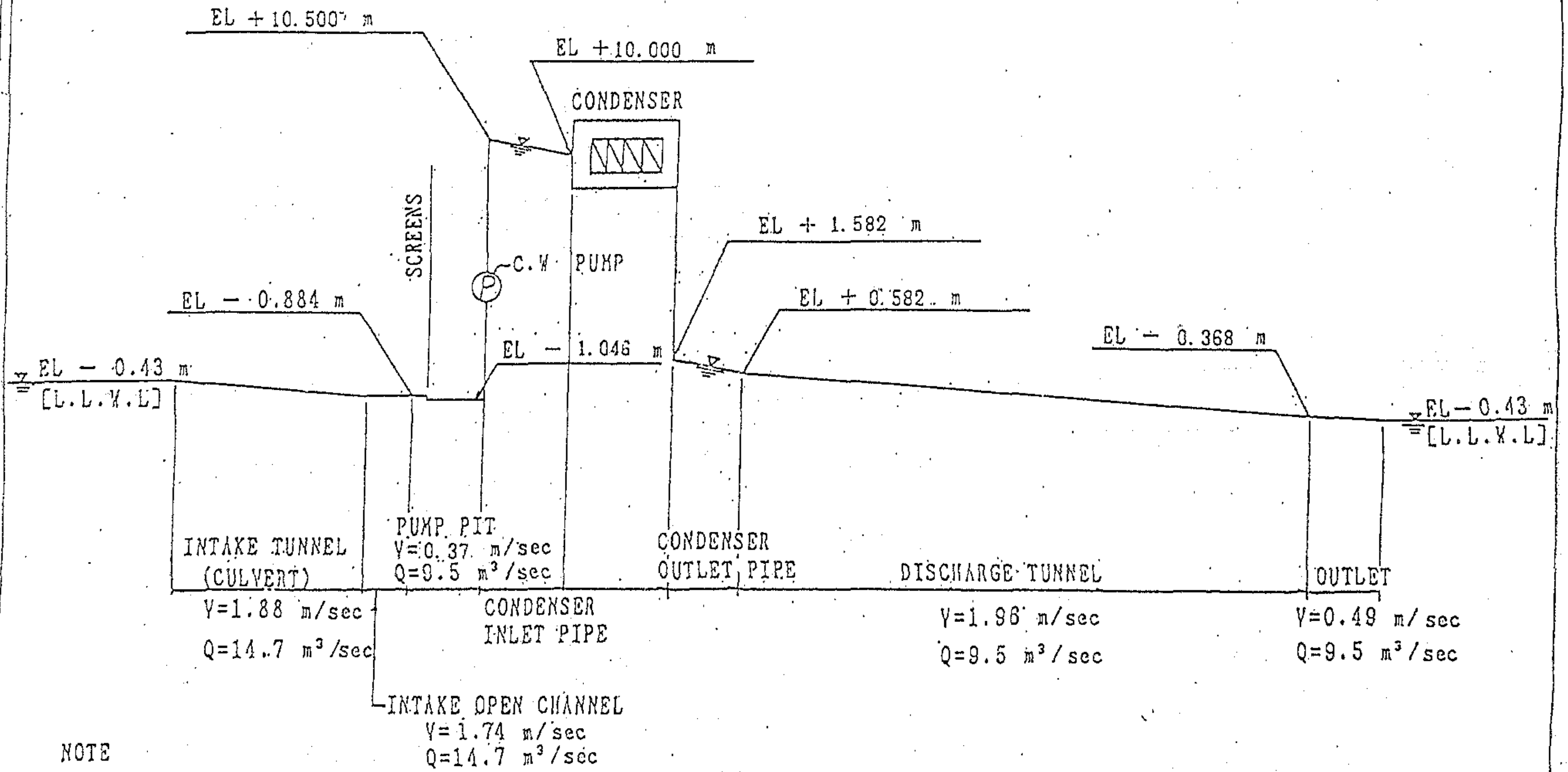
Fig 1. The Results of Hydrographic Calculaton

(UNIT I)



NOTE

V: Water velocity (m/sec)

Q: Quantity of water (m^3/sec)

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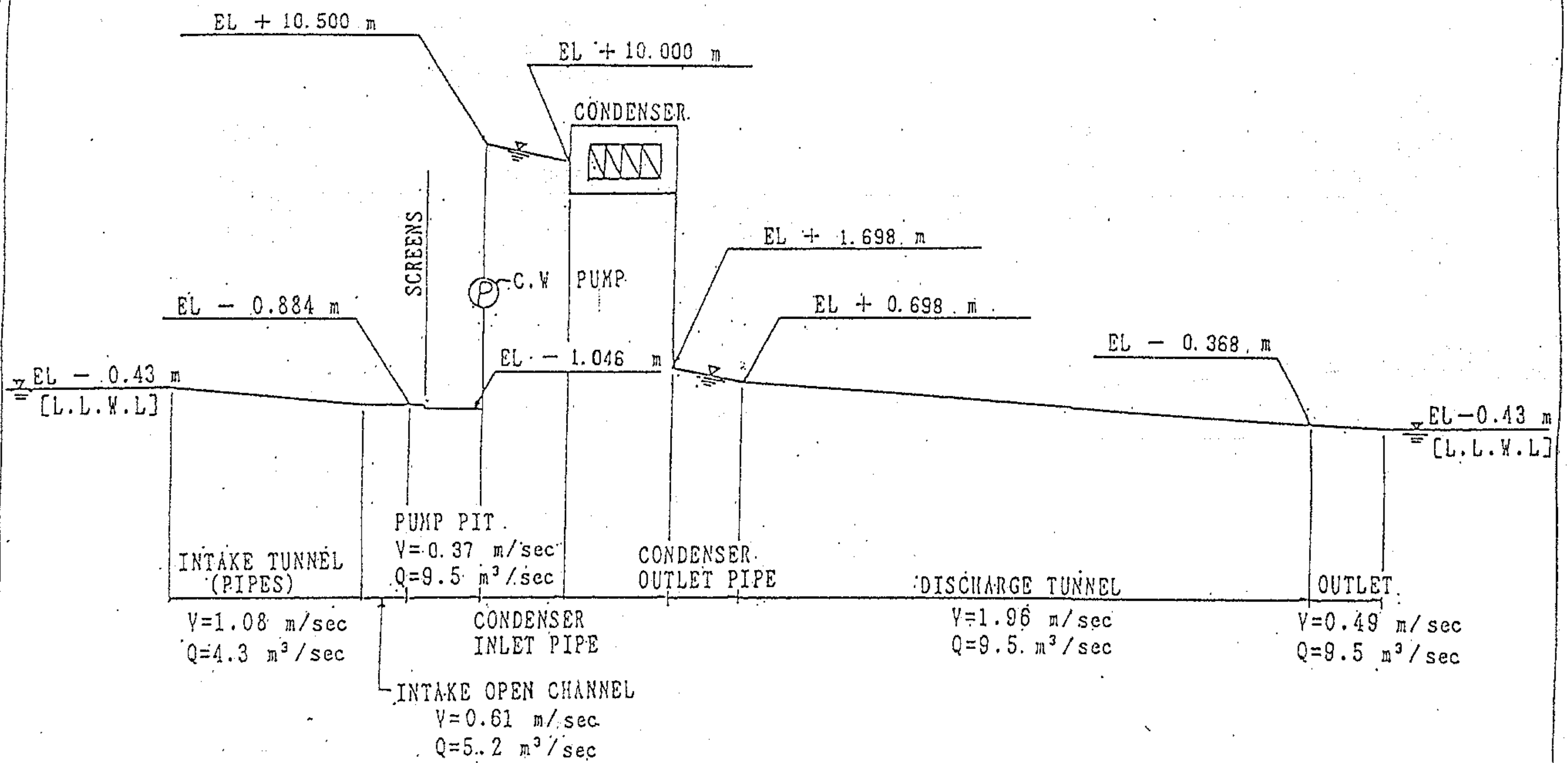
Fig 2. 1 Results of Hydrographic Calculaton

(UNIT II)



NOTE

V: Water velocity (m/sec)

Q: Quantity of water (m^3/sec)

2. 設計条件

1) 水 位

All calculations are executed at the lowest low water level.

L.L.W.L : E.L. - 0.43 m

2) 粗度係数

a) Ordinary concrete such as cast-in-field concrete

the roughness : $n = 0.015$

b) Ordinary concrete with shells stuck

the roughness : $n = 0.02$

3) 取水構造物の流量計算

The water flow chart of Intake structures are shown in Fig 3.

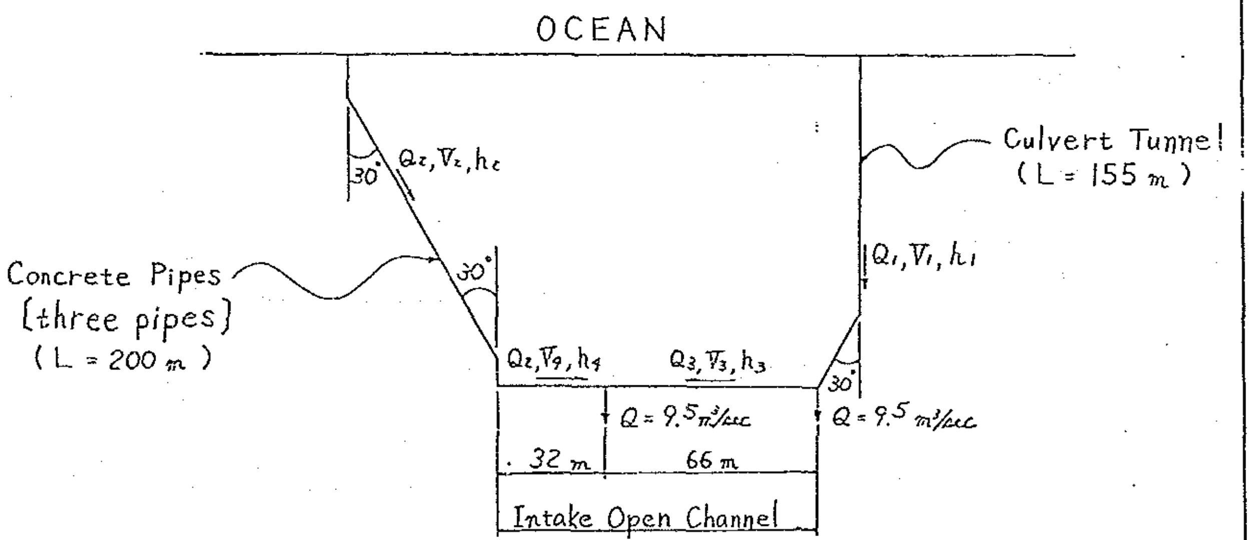


Fig 3. The water flow chart of Intake structures

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取水構造物の流量は、下記の方程式を解くことによって計算される。

$2Q = Q_1 + Q_2 = 19.0\ m^3$ ——— ①

$Q = Q_2 + Q_3 = 9.5\ m^3$ ——— ②

$Q_3 = Q_1 - Q = Q_1 - 9.5\ m^3$ ——— ③

$h_2 + h_4 = h_1 + h_3$ ——— ④

provided that $Q_1 \leqq 2Q$

$Q_2,\ Q_3 \leqq Q$

Where Q1 : Quantity of culvert tunnel [m^3/sec]

Q2 : Quantity of concrete pipes [m^3/sec]

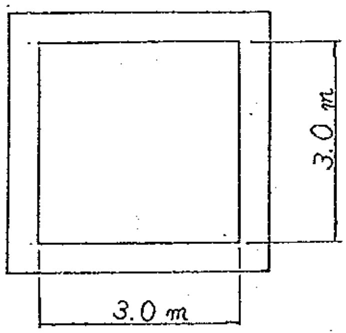
[Three pipes located]

Q3 : Quantity of Intake Open Channel (at culvert side) [m^3/sec]

Q4 : Quantity of Intake Open Channel (at concrete pipe side) [m^3/sec]

a) 取水カルバートの水頭損失計算

typical section of culvert



S : the wet perimeter [m]

A : the area [m^2]

R : the hydrographic mean level [m]

Shell deposits 10cm is considered for calculation.

$S = 4 \times (3.0 - 0.2) = 11.2\ m$

$A = 2.8 \times 2.8 = 7.84\ m^2$

$$R = \frac{A}{S} = \frac{7.84}{11.2} = 0.7\ m$$

1003

i) The head loss due to inflow h_{e1},

$$V = \frac{Q_1}{A} = \frac{Q_1}{7.84} = 0.1276\ Q_1$$

$$h_{e1} = fe \cdot \frac{v^2}{2g} = 0.5 \times \frac{(0.1276Q_1)^2}{2 \times 9.8} = 0.0004\ Q_1{}^2$$

Where f_e : the coefficient of the inflow loss = 0.5

ii) The head loss due to the wall surface friction h_{f1}

$$h_{f1} = \frac{Q_1{}^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{Q_1{}^2 \cdot 0.02^2 \cdot 155}{7.842 \times 0.7^{4/3}} = 0.0016\ Q_1{}^2$$

iii) The head loss due to bend h_{b1}

$$h_{b1} = f_{b1} \cdot \frac{v^2}{2g} = 0.073 \times \frac{(0.1276\ Q_1)^2}{2 \times 9.8} \fallingdotseq 0.0001\ Q_1{}^2$$

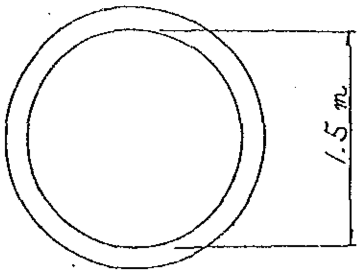
Where f_{b1} : the coefficient of the bend loss = 0.073

Accordingly the head loss due to Intake Culvert is calculated as hereinafter.

$$h_1 = h_{e1} + h_{f1} + h_{b1} = (0.0004 + 0.0016 + 0.0001)Q_1{}^2 = 0.0021\ Q_1{}^2$$

b) 取水コンクリートパイプの水頭損失

typical section of concrete pipe



Shell deposits 10cm is considered for the calculation.

$$S = \pi \times (1.5 - 2 \times 0.1) = 4.08 \text{ m}$$

$$A = \frac{1}{4} \times \pi \times 1.3^2 = 1.33 \text{ m}^2$$

$$R = \frac{A}{S} = \frac{1.33}{4.08} = 0.326 \text{ m}$$

i) The head loss due to inflow h_{e2}

$$V = \frac{Q_2}{3A} = \frac{Q_2}{1.33 \times 3} = 0.2506\ Q_2$$

$$h_{e2} = f_e \cdot \frac{v^2}{2g} = 0.5 \times \frac{(0.2506\ Q_2)^2}{2 \times 9.8} = 0.0016\ Q_2^2$$

Where f_e : the coefficient of the inflow loss = 0.5

ii) The head loss due to the wall surface friction h_{f2}

$$h_{f2} = \frac{Q_2^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{(Q_2/3)^2 \cdot 0.02^2 \cdot 200}{1.33^2 \cdot 0.326^{4/3}} = 0.0224\ Q_2^2$$

iii) The head loss due to the bend loss h_{b2}

$$h_{b2} = 2 \cdot f_b \cdot \frac{v^2}{2g} = 2 \times 0.073 \times \frac{(0.2506\ Q_2)^2}{2 \times 9.8} = 0.0005\ Q_2^2$$

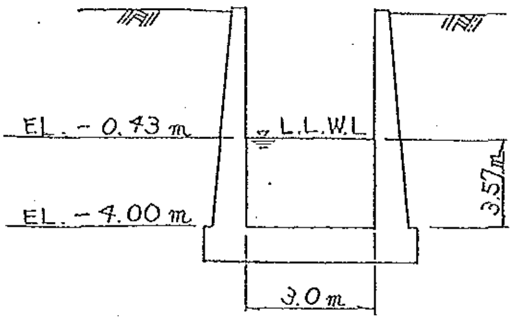
Accordingly the head loss of Intake Pipe Tunnel is calcurated as hereinafter.

$$h_2 = h_{e2} + h_{f2} + h_{b2} = 0.0016Q_2^2 + 0.0224Q_2^2 + 0.0005Q_2^2 = 0.0245Q_2^2$$

$$= 0.0245(19.0 - Q_1)^2$$

c) 開渠取水路の水頭損失（カルバート側）：

the section of Intake Open Channel



Shall deposits 10cm are considered for the calculation

$$S = 2 \times 3.47 + (3 - 2 \times 0.1) = 9.74 \text{ m}$$

$$A = 2.8 \times 3.47 = 9.72 \text{ m}^2$$

$$R = \frac{A}{S} = \frac{9.72}{9.74} = 1.00 \text{ m}$$

The head loss h_3 is the same as the head loss due to the wall surface friction.

$$h_3 = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{Q_3{}^2 \times 0.02^2 \times 66}{9.72^2 \times 1.0^{4/3}} = 0.0003Q_3{}^2$$

d) 開渠取水路の水頭損失（コンクリートパイプ側）

The section and the process of calculation are the same as C), therefore

$$h_4 = \frac{Q_2{}^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{Q_2{}^2 \times 0.02^2 \times 32}{9.72^2 \times 1.0^{4/3}} = 0.0001\ Q_2{}^2 = 0.0001\ (19.0 - Q_1)^2$$

Above calculated the head losses are substituted into the previous equation ④ here.

$$(0.0245 + 0.0001)\ (19.0 - Q_1)^2 = 0.0021\ Q_1{}^2 + 0.0003\ (Q_1 - 9.5)^2$$

$$0.0246(Q_1{}^2 - 38Q_1 + 361) = 0.0024Q_1{}^2 - 0.0057Q_1 + 0.0271$$

$$0.0222\ Q_1{}^2 - 0.9291\ Q_1 + 8.8535 = 0$$

Q_1 is determined by solving the above equation.

$\underline{Q_1 = 14.7\ \text{m}^3/\text{sec}}$

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Accordingly other quantities are calculated as hereinafter.

$$Q_2 = 19.0 - Q_1$$
$$= 19.0 - 14.7$$
$$= \underline{4.3\ m^3/sec}$$

$$Q_3 = 9.5 - Q_2$$
$$= 9.5 - 4.3$$
$$= \underline{5.2\ m^3/sec}$$

3. 損失水頭の計算

1) 既設取水トンネル

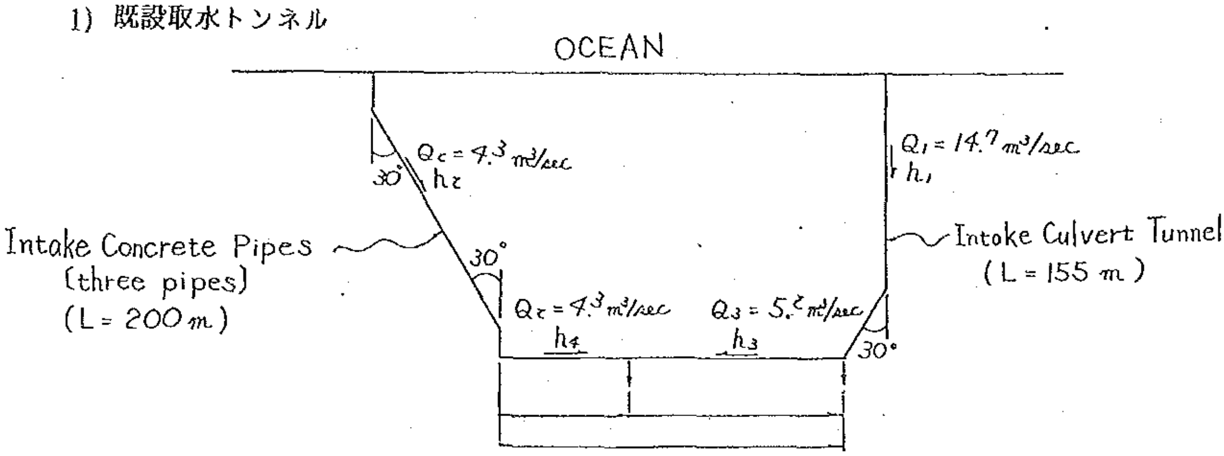


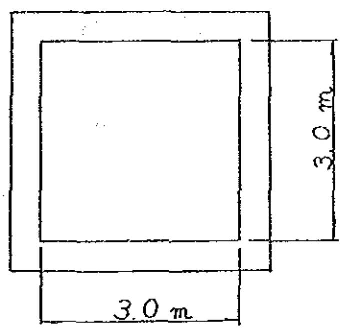
Fig 4. The water flow diagram

a) 既設カルバートの損失水頭

The sectional dimensions S, A and R are calculated as hereinafter

Shell deposits 10cm is considered for calculations.

typical section of Culvert



S : the wet perimeter

$S = 4 \times (3.0 - 0.2) = 11.2$ m

A : the area

$A = 2.8 \times 2.8 = 7.84$ m^2

R : the hydrographic mean depth

$$R = \frac{A}{S} = \frac{7.84}{11.2} = 0.7 \text{ m}$$

i) The head loss due to inflow h_e

$$V = \frac{Q}{A} = \frac{14.7}{7.84} = 1.88 \text{ m/sec}$$

The head loss h_e

$$h_e = f_e \cdot \frac{v^2}{2g} = 0.5 \times \frac{1.88^2}{2 \times 9.8} = 0.09 \text{ m}$$

Where f_e : the coefficient of the inflow loss = 0.5

ii) The head loss due to the wall surface friction h_f

$$h_f = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{14.7^2 \times 0.02^2 \times 155}{7.84^2 \times 0.7^{4/3}} = \underline{0.351 \text{ m}}$$

iii) The head loss due to bend h_{be}

$$h_{be} = f_{be} \cdot \frac{v^2}{2g} = 0.073 \times \frac{1.88^2}{2 \times 9.8} = \underline{0.013 \text{ m}}$$

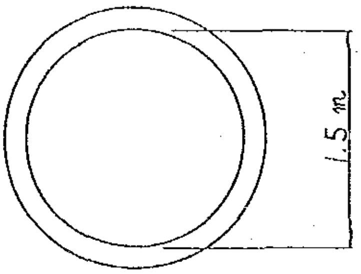
Where f_b : the coefficient of the bend loss = 0.073
(the angle of bend = 30°)

Accordingly calculating culvert tunnel's head loss h_1

$$h_1 = h_e + h_f + h_{be} = 0.09 + 0.351 + 0.013 = \underline{0.454 \text{ m}}$$

b) 既設コンクリートパイプの損失水頭 h_2
The sectional dimensions S, A and R are calculated as hereinafter.

the section of concrete pipe



Shell deposits 10cm is considered for calculation.

$$S = \pi \times (1.5 - 2 \times 0.1) = 4.08 \text{ m}$$

$$A = \frac{1}{4} \times \pi \times 1.3^2 = 1.33 \text{ m}^2$$

$$R = \frac{A}{S} = \frac{1.33}{4.08} = 0.326 \text{ m}$$

i) The head loss due to inflow h_e

$$V_1 = \frac{Q}{A} = \frac{1/3 \times 4.3}{1.33} = 1.08 \text{ m/sec}$$

$$h_e = f_e \cdot \frac{v^2}{2g} = 0.5 \times \frac{1.08^2}{2 \times 9.8} = \underline{0.030 \text{ m}}$$

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ii) The head loss due to the wall surface friction h_f

$$h_f = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{1.43^2 \times 0.02^2 \times 200}{1.33^2 \times 0.326^{4/3}} = \underline{0.412\ m}$$

iii) The head loss due to bend h_{be}

$$h_{be} = f_{be} \cdot \frac{v^2}{2g} = 0.073 \times \frac{1.08^2}{2 \times 9.8} = \underline{0.004\ m}$$

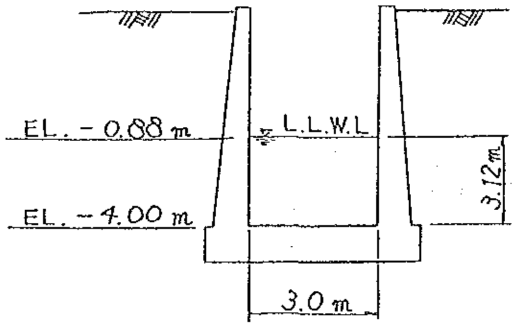
Accordingly calculating the head loss h_2

$$h_2 = h_e + h_f + h_{be} = 0.03 + 0.412 + 0.004 = \underline{0.446\ m}$$

2) 開渠取水路

a) 損失水頭 h_3

the section of Intake Open Channel



Shell deposits 10 cm is considered for the calculations.

$$S = 2 \times 3.02 + (3 - 2 \times 0.1) = 8.84 \text{ m}$$

$$A \doteq 2.8 \times 3.02 = 8.46 \text{ m}^2$$

$$R = \frac{A}{S} = \frac{8.46}{8.84} = 0.96 \text{ m}$$

The head loss h_3 is the same as the head loss due to the wall surface friction.

$$h_3 = \frac{Q_3{}^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{5.2^2 \times 0.02^2 \times 66}{8.46^2 \times 0.96^{4/3}} = \underline{0.010 \text{ m}}$$

b) 損失水頭 h_4

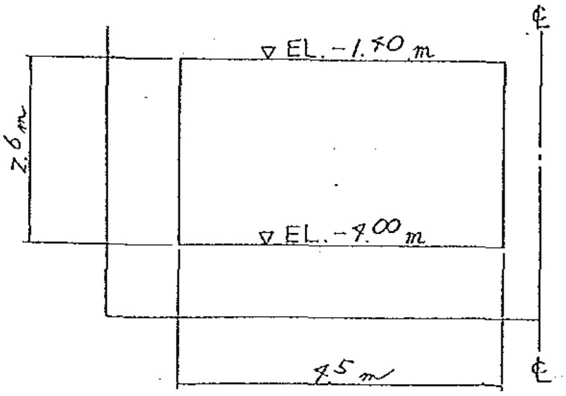
The process of calculation is the same as a).

$$h_4 = \frac{Q_3{}^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{4.3^2 \times 0.02^2 \times 32}{8.46^2 \times 0.96^{4/3}} = \underline{0.003 \text{ m}}$$

3) ポンプ・ピット

a) カーテンウォールによる損失水頭 hc

the section of the entrance



Shell deposits 10cm are considered for the calculation.

$A = 4.3 \times 2.4 = 10.32\ m^2$

$Q = \frac{1}{2} \times 9.5 = 4.75\ m^3/sec$

$V = \frac{Q}{A} = \frac{4.75}{10.32} = 0.46\ m/sec$

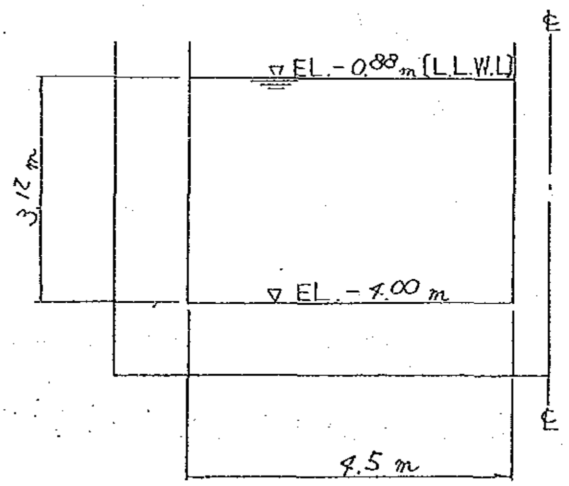
$$h_c = \frac{Q^2}{C^2 \cdot A^2 \cdot 2g} - \frac{V^2}{2g} = \frac{4.75^2}{0.5^2 \times 10.32^2 \times 2 \times 9.8} - \frac{0.46^2}{2 \times 9.8}$$

$$= 0.03\ m$$

where C : the inflow coefficient = 0.5

b) 壁面摩擦による損失水頭 h_f

the section of Screen Room



Shell deposits 10cm are considered for the calculation.

$A = 4.3 \times 3.02 = 12.99\ m^2$

$S = 2 \times 3.02 + 4.3 = 10.34\ m$

$R = \frac{A}{S} = \frac{12.99}{10.34} = 1.26\ m$

$$h_{f1} = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{4.75^2 \times 0.02^2 \times 13}{12.99^2 \times 1.26^{4/3}} = 0.0005\ m$$

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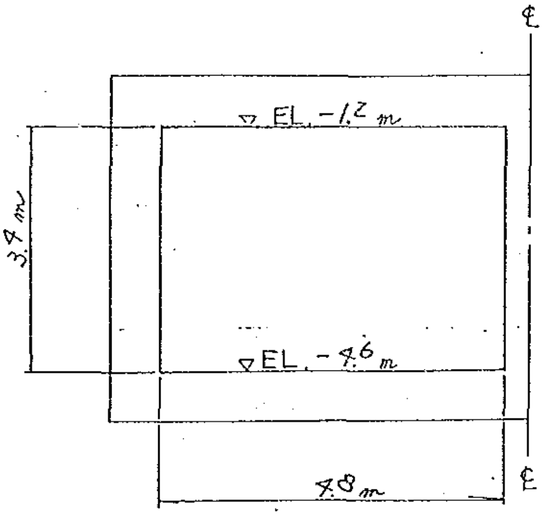
the mean section of Connected Culvert



Shell deposits 10cm are considered for the calculation.

$A = 4.3 \times 3.2 = 14.72\ m^2$

$S = 2 \times (\ 3.2 + 4.6\ ) = 15.6\ m$

$R = \dfrac{A}{S} = \dfrac{14.72}{15.6} = 0.94\ m$

$$h_{f2} = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{4.75^2 \times 0.02^2 \times 23}{14.72^2 \times 0.94^{4/3}} = 0.001\ m$$

Accordingly h_f is calculated as follows.

$$h_f = h_{f1} + h_{f2} = 0.0005 + 0.001 = 0.0015$$

c) バー・スクリーンによる損失水頭 h_{ba}

The approach velocity to bar screen V_a

$$V_a = \frac{Q}{A} = \frac{4.75}{12.99} = 0.37 m/sec < 0.40\ m/sec$$

Therefore the head loss h_{ba} is assumed to be 0.03 m.

(The above value 0.03 m/sec is regulated by U.S Bureau of Reclamation.)

d) トラベリング・スクリーンによる損失水頭 h_{tr}

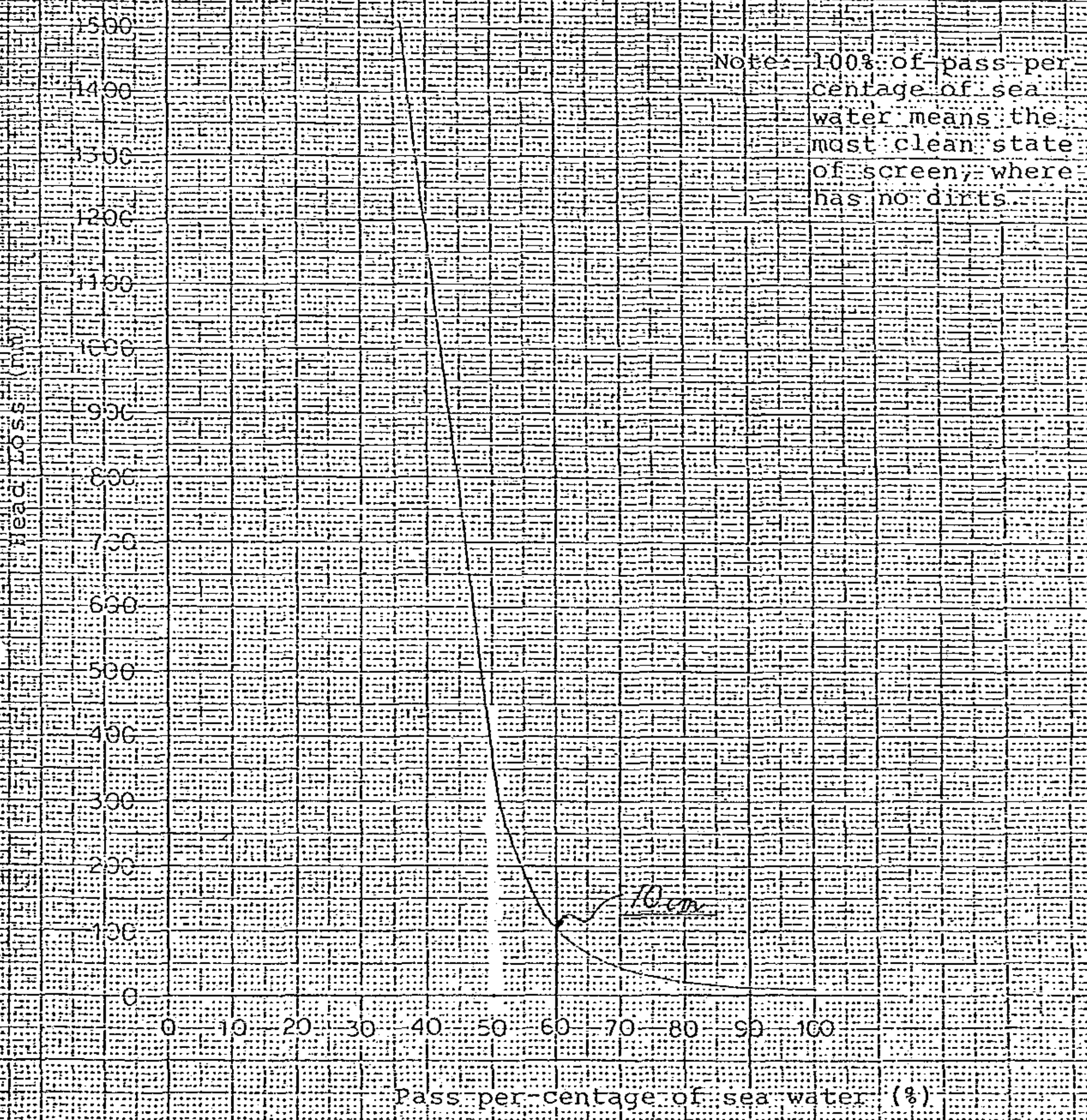
According to Fig 5, the head loss h_{tr} is assumed to be 0.10 m for the cleaness factor 60% of screen.

Therefore the head loss due to Pump Pit h_p is calculated as follows.

$$h_p = h_c + h_f + h_{ba} + h_{tr} = 0.03 + 0.0015 + 0.03 + 0.1 = 0.162\ m$$

Fig.5 Travelling Screen

Pass per centage of sea water
and the head loss



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4) 放水路（カルバート・トンネル）

放水カルバートの損失水頭は、復水器の放水鉄管路の損失水頭を除いて、下記のように計算される。

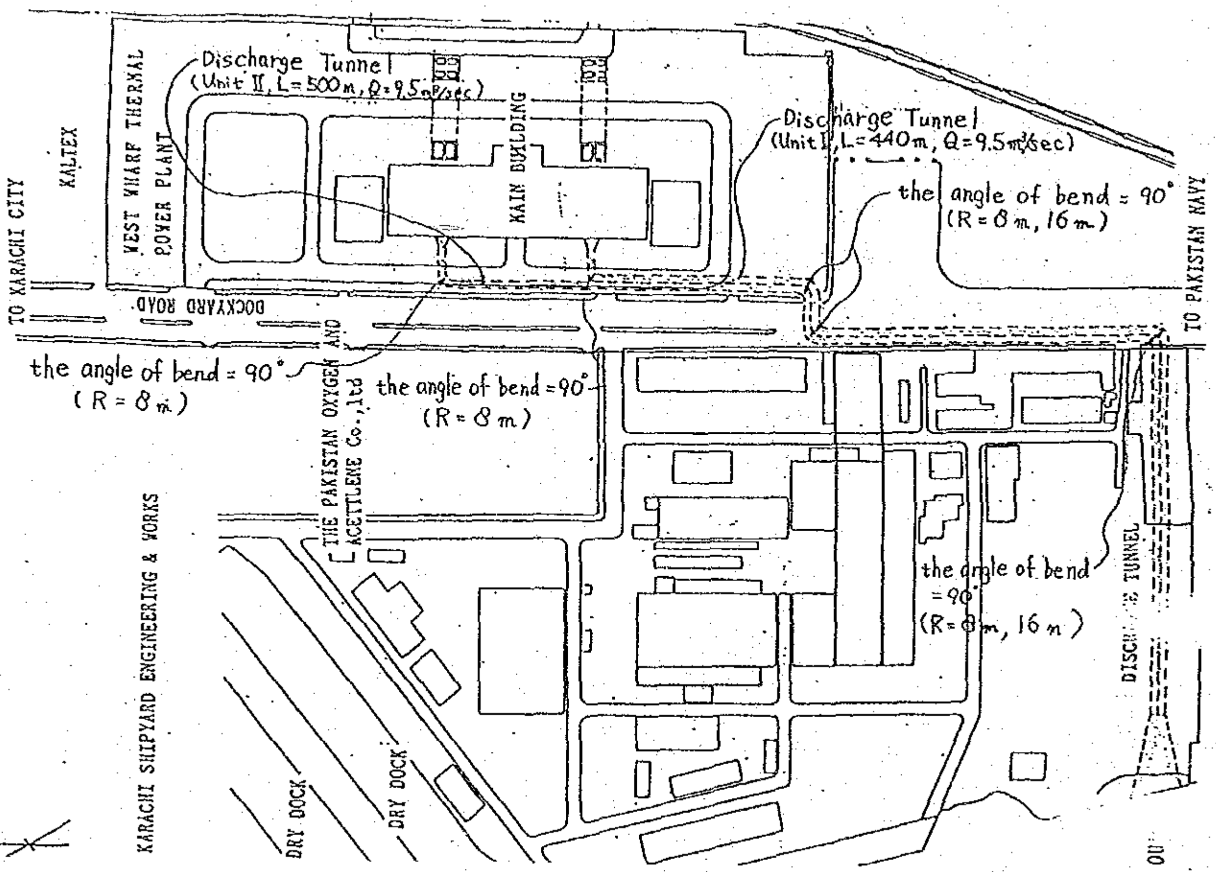
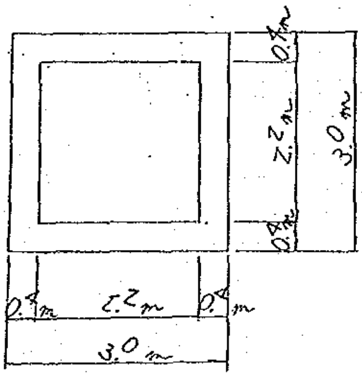


Fig 6. Plan of Discharge Tunnels

a) 放水路（Unit I）

the section of discharge tunnel



$$S = 4 \times 2.2 = 8.8 \text{ m}$$

$$A = 2.2 \times 2.2 = 4.84 \text{ m}^2$$

$$R = \frac{A}{S} = \frac{4.84}{8.8} = 0.55 \text{ m}$$

$$V = \frac{9.5}{4.84} = 1.96 \text{ m/sec}$$

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i) The head loss due to the water surface friction h_f

$$h_f = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{9.5^2 \times 0.015^2 \times 440}{4.84^2 \times 0.55^{4/3}} = \underline{0.846 \text{ m}}$$

ii) The head loss due to double curves of the same type h_{cu}

$$h_{cu} = 2 \times \left[\left\{ 0.131 + 0.1632 \left(\frac{D}{\rho_1} \right)^{3.5} \right\} \left(\frac{90^\circ}{90^\circ} \right) + \left\{ \left(0.131 + 0.1632 \left(\frac{D}{\rho_2} \right)^{3.5} \right\} \left(\frac{90^\circ}{90^\circ} \right) \right] \cdot \frac{V^2}{2g}$$

$$= 2 \times \left[\left\{ 0.131 + 0.1632 \left(\frac{2.48}{8} \right)^{3.5} \right\} \left(\frac{90^\circ}{90^\circ} \right) + \left\{ \left(0.131 + 0.1632 \left(\frac{2.48}{10.6} \right)^{3.5} \right\} \left(\frac{90^\circ}{90^\circ} \right) \right] \times \frac{1.96^2}{2 \times 9.8}$$

$$= \underline{0.104 \text{ m}}$$

Where ρ : the radius of curvature $\rho_1 = 8$ m $\rho_2 = 10.6$ m

D : the diameter of culvent

$$D = \sqrt{\frac{4.84 \times 4}{\pi}} = 2.48 \text{ m}$$

Accordingly the head loss due to discharge tunnel for unit I h_{c1} is calculated as hereinafter.

$$h_{c1} = h_f + h_{cu} = 0.846 + 0.104 = \underline{0.950 \text{ m}}$$

b) 放水路 (Unit II)

The section of culvert and the process of calculations are the same as culvert I.

i) The head loss due to the water surface friction h_f

$$h_f = \frac{9.5^2 \times 0.015^2 \times 500}{4.84^2 \times 0.55^{4/3}} = \underline{0.962 \text{ m}}$$

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ii) The head loss due to curve h'_{cu}

h'_{cu} is calculated as hereinafter.

$$h'_{cu} = [\, 3 \times \{0.131 + 0.1632 \times (\frac{2.48}{8})^{3.5} \times (\frac{90^\circ}{90^\circ})$$

$$+ \{0.131 + 0.1632 \times (\frac{2.48}{10.6})^{3.5} \times (\frac{90^\circ}{90^\circ})\,] \times \frac{1.96^2}{2 \times 9.8}$$

$$= \underline{0.104\ \text{m}}$$

Accordingly the head loss due to culvert II h_{c2} is calculated as hereinafter.

$$h_{c2} = h_f + h_{cu} = 0.962 + 0.104 = \underline{1.066\ \text{m}}$$

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5) アウトレット

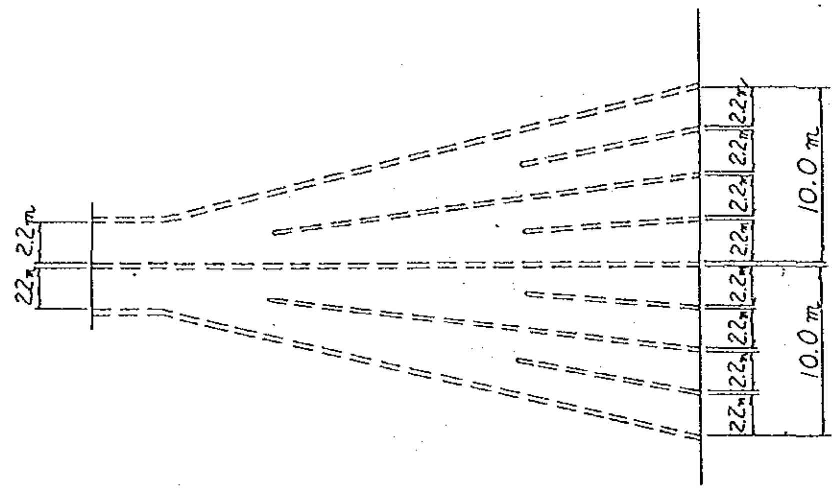
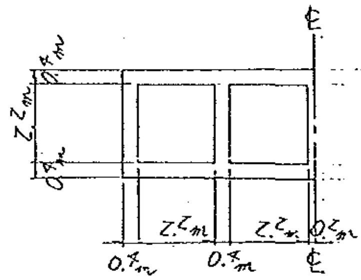


Fig 7. Plan of outlet

Both outlets of unit I and unit II are the same structures, so the head loss calculation is all the same.

a) The head loss due to outlet h_o (per one culvert box)

typical section of outlet (one unit)



$S = 4 \times 2.2 = 8.8$ m (per one box)

$A = 2.2 \times 2.2 = 4.84$ m² (per one box)

$R = \dfrac{A}{S} = \dfrac{4.84}{8.8} = 0.55$ m (per one box)

$V = \dfrac{Q}{A} = \dfrac{1/2 \times 9.5}{4.84} = 0.98$ m/sec (per one box)

i) The head loss due to the water surface friction h_f

$$h_f = \frac{Q^2 \cdot n^2 \cdot L}{A^2 \cdot R^{4/3}} = \frac{4.75^2 \times 0.015^2 \times 40}{4.84^2 \times 0.55^{4/3}} = \underline{0.019 \text{ m}}$$

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ii) The head loss due to the gradual expansion h_g

The entrance area of outlet A_1 (one unit)

$$A_1 = 2.2 \times 2.2 = 4.84\ m^2$$

The exit area of outlet A_2 (one unit)

$$A_2 = 4 \times 2.2 \times 2.2 = 19.36\ m^2$$

$$V_1 = \frac{Q_1}{A_1} = \frac{9.5}{4.84} = 1.96\ m/sec$$

$$V_2 = \frac{9.5}{A_2} = \frac{9.5}{19.36} = 0.49\ m/sec$$

$$h_g = f_g \cdot f_s \cdot \frac{(V_1 - V_2)^2}{2g} = 0.7 \times 0.563 \times \frac{(1.96 - 0.49)^2}{2 \times 9.8} = \underline{0.043\ m}$$

Where f_g : the coefficent of the gradual expansion loss = 0.7

f_s : the coefficent of the sudden expansion loss

$$f_s = \left(1 - \frac{A_1}{A_2}\right)^2 = \left(1 - \frac{4.84}{19.36}\right)^2 = 0.563$$

Accordingly the head loss due to outlet h_o is calculated as hereinafter.

$$h_o = h_f + h_g = 0.019 + 0.043 = \underline{0.062\ m}$$

FORM 04

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CV－4　取水路開渠の構造設計

目　　　　次

1．開渠取水路の構造計算

1.1　土質条件

施工区域周辺のボーリングデータは、図－１の如くである。
尚、基礎地盤上のＮ値は次の式によって計算される。

$$N = \frac{(10+12)\times 2.0+(12+11)\times 2.0+(11+13)\times 2.0+(13+6)\times 2.0+(6+9)\times 1.54}{2\times 9.54}$$

$$\fallingdotseq 10$$

上の計算により、内部摩擦角は次式によって計算される。

$$\phi = (\sqrt{15N}+15)^\circ = (\sqrt{15\times 10}+15)^\circ \fallingdotseq 27^\circ$$

the bulk density of soil above the ground wate γ : $\gamma = 1.9\ t/m^3$

the bulk density of soil above the ground wate γ': $\gamma' = 1.0\ t/m^3$

他の基礎条件データは、『一般土木設計条件』に記述されている。
(vid.No EW -1001)

1011

SITE : WEST WHARF THERMAL POWER STATION, KARACHI.

CLIENT : KARACHI ELECTRIC SUPPLY CORPORATION.

BORE CHART OF BORING No.4

Ground Water Level	Reduced Levels M/K	Depth METERS	Thickness of Layers in (Meter)	STRATAENCOUNTERED	Soil Symbols	Diameter of Boring	Penetration Test Blow No. (20 40 60 80 10)
1.0 (m)	EL +4.538 +3.538 +0.838	0.00 r =1.9 r'=1.0 3.70	3.70	The ground water surface filling material of brown medium to coarse sand with gravels, pebbles and clay.			12 blows @ 2m.
20/12/87	-1.262	r'=1.0 5.80	2.10	Brown medium silty medium to coarse SAND.			11 blows @ 4m.
	-5.000 -5.462	r'=1.0 10.00	4.20	Dark grey loose to medium silty fine to coarse SAND, traces GRAVELS. Foundation Level		5"ø	13 blows @ 6m. 6 blows @8m. 9 blows @ 10m.
27/12/87	-11.462	r'=1.0 16.00	6.00	Grey loose to medium silty fine to medium SAND.			22 blows @ 12m. 24 blows @ 14m. 27 blows@ 16m.
		r'=1.0					cont. on sheet 2.

Remarks : GROUNDWATER TABLE AT 1.00 METER.

Date :- 27/12/87.

Fig 1. Soil column diagram

FORM 04

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1.2 構造設計の概要

開渠取水路の構造は、図－2に示されている。
この構造は、梁を除いて剛構造として考えられる。

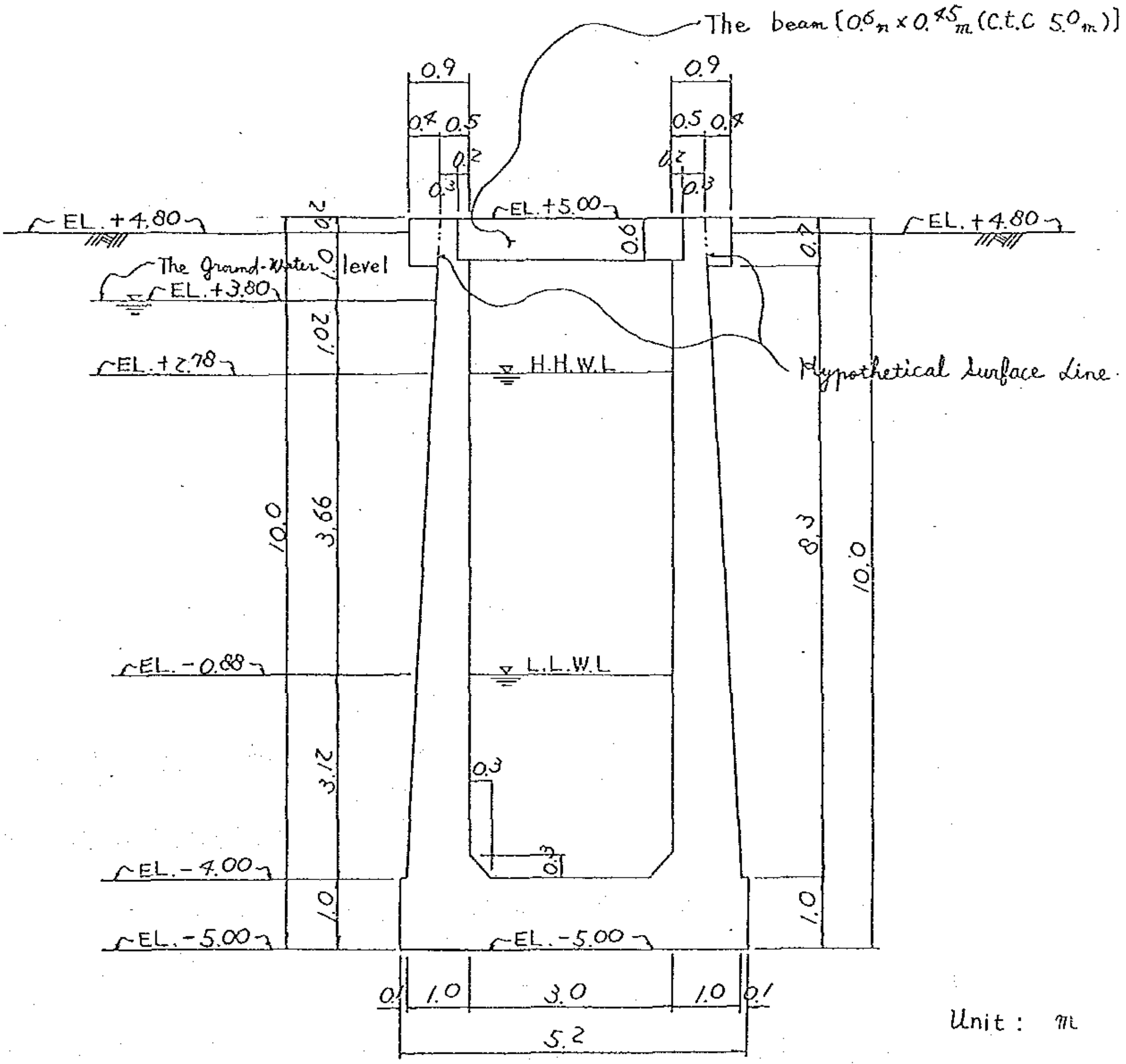

Fig.2 Typical section of Intake Open Channel

The structural design calculation is executed at the lowest low water level.
(EL − 0.88 m) (considered for the water head loss due to Intake Tunnel).
↓
(vid.1.c,P4,No EWC-1004)

1.3 安定計算

1) 鉛直力（単位奥行き長さ 1 m 当り）

a) Base slab

$$W_{c1} = 5.2 \times 1.0 \times 2.45 = 12.7 \text{ t}$$

b) Side wall (at one side)

$$W_{c2} = (0.7 \times 0.7 + \frac{1}{2} \times (0.54+1.0) \times 8.3 + \frac{1}{2} \times 0.3 \times 0.3) \times 2.45$$

$$= 17.0 \text{ t}$$

c) Beam

$$W_{c3} = 3.0 \times 0.6 \times 0.45 \times 2.45 \div 5.0 = 0.4 \text{ t}$$

d) Soil weight W_s (at one side)

$$W_s = (0.2 \times 0.5 + \frac{1}{2} \times (0.56 + 0.1) \times 8.3) \times 1.9 = 5.4 \text{ t}$$

e) Water weight

Water weight W_w is calculated at the highest high water level (EL + 2.78 m)
(considered for the water head loss due to Intake Tunnel.) ↓

(vid.1.b,P3,No. EWC-1004)

$$W_w = (6.78 \times 3.0 - 0.3 \times 0.3) \times 1.0 = 20.3 \text{ t}$$

f) Buoyancy

Buoyancy U_b is working to the portion of concrete structure under H.H.W.L, so U_b is calculated as follows.

$$U_b = \{ 5.2 \times 1.0 + 0.3 \times 0.3 + (0.59 + 1.0) \times 6.78 \} \times 1.0$$

$$= 16.1 \text{ t}$$

FORM 04

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According to the above calculation, the summarized vertical forces are shown in Table 1.

Table 1. Summarized table of vertical forces (per 1 m unit length)

Species	Vertical force	Remarks
W_{c1}	12.7 t	Base slab
W_{c2}	34.6 t	Side wall
W_{c3}	0.4 t	Connected beam
W_s	11.0 t	Soil weight
W_w	20.3 t	Water weight
U_b	− 16.1 t	Buoyancy
TOTAL	V = 62.9 t	

2) 地盤反力 q_1

$$q_1 = \frac{V}{B.L} \cdot \left(1 \pm \frac{6e}{B}\right)$$

Where e : the eccentric distance
e = 0

$$= \frac{62.9}{5.2 \times 1.0}$$

$$= 12.1\ t/m^2$$

1105

3) 支持力の検討

The ultimate bearing capacity is calculated by the following equation in consideration of the unbalanced inclination.

$$q_u = \alpha K C N_c + K q N_q + \frac{1}{2} \gamma_1 \beta B' N_r$$

Where C : soil cohesion $= 0\ t/m^2$

q : the surcharge load

$q = 1.9 \times 1.0 + 1.0 \times 8.8 = 10.7\ t/m^2$

A' : the effective load area (m^2)

$A' = 5.2 \times 1.0 = 5.2\ m^2$

γ_1 : the bulk density of the bearing soil(t/m^3)

$\gamma_1 = 1.0\ t/m^3$

(γ_1 is the bulk density under the ground water.)

B' : the effective width considered for the eccentric distance.

$B' = B - 2e_b = 5.2 - 2 \times 0 = 5.2\ m$

where B : the basic width

C_b : the eccentric distance

$\alpha . \beta$: the coefficient of basic form $\alpha = \beta = 1.0$

K : the extra coefficient for the embedded effect $K = 1.0$

N_c, N_q, N_r : the bearing coefficients considered for the load inclination, and these coefficients are adopted from the following graphs.

$N_c = 25$ (from Fig 3.)
$N_q = 14$ (from Fig 4.)
$N_r = 9$ (from Fig 5.)

1106

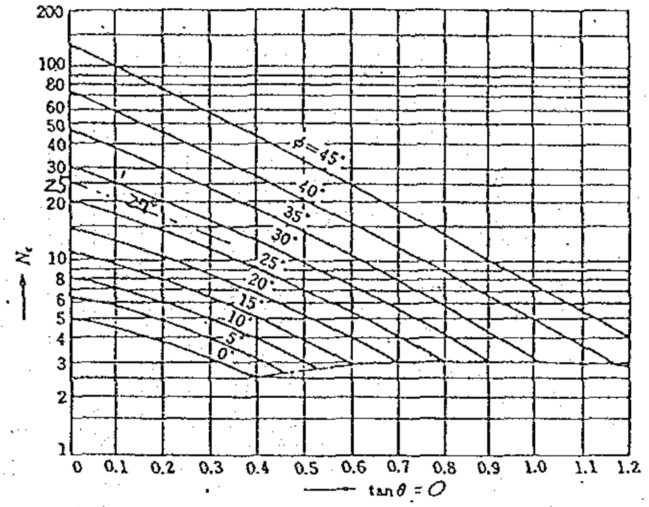

Fig.3 Graph of the bearing coefficient N_c

where tan θ : tan θ = $\frac{H}{V}$ = 0

V : Vertical Force at the foundation V = 60 t

H : Horizontal Force at the foundation H = 0 t

because horizontal forces are equilibriumed at both sides.

ϕ : The angle of the internal friction

ϕ = 27°

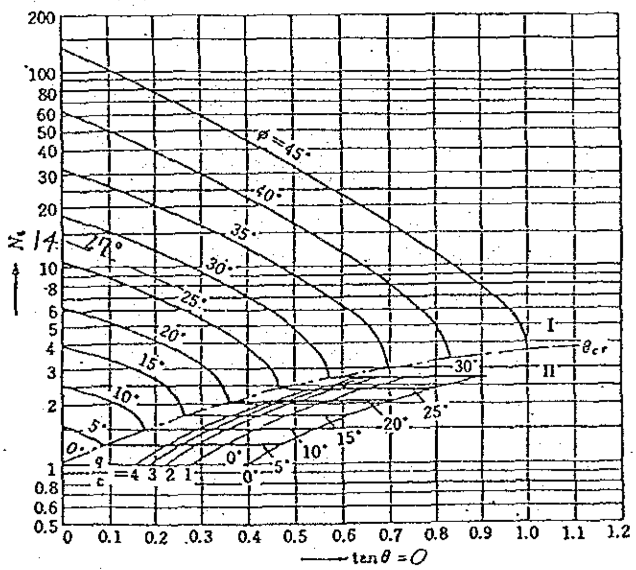

Fig.4 Graph of the bearing coefficient N_q

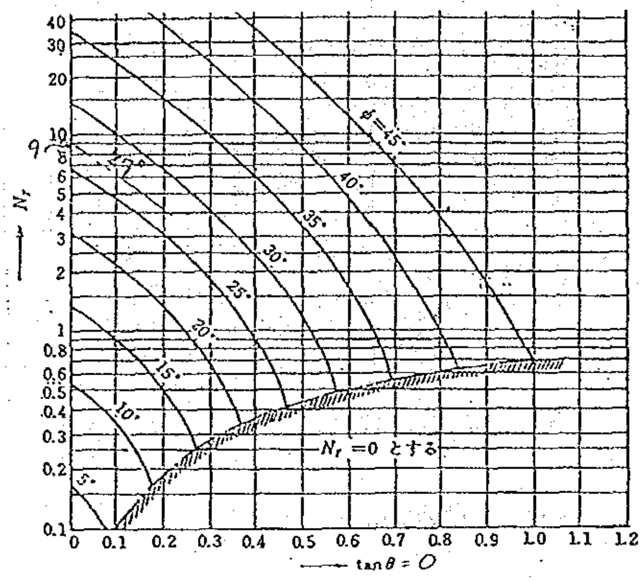

Fig.5 Graph of the bearing coefficient N_r

Accordingly the ultimate bearing capacity q_u is calculated as below.

$$q_u = 1.0 \times 10.7 \times 14 + \frac{1}{2} \times 1.0 \times 1.0 \times 5.2 \times 9 = 173 \text{ t}$$

4) 許容支持力 q_a

The allowable bearing capacity is calculated as below.

$$q_a = \frac{1}{F_s} \cdot q_u = \frac{1}{3} \times 173 \fallingdotseq 57 \text{ t/m}^2 \underset{\text{O.K}}{>} q_1 = 11.5 \text{ t/m}^2$$

Where F_s : the factor of safety $F_s = 3$

Therefore the spread foundation is adopted for the foundation of Intake Open Channel.

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5) 浮上りの検討

浮上りの検討は、常時（水位は、L.L.W.L）及び施工時（内水は空虚）にて行なわれ、その計算は次のようになる。

a) Total vertical force

i) at normal

$$V_1 = 12.7 + 34.6 + 0.4 + 11.0 + (3.12 \times 3.0 - 0.3 \times 0.3) \times 1.0 = 68.0 \text{ t}$$

ii) at construction

$$V_2 = 12.7 + 34.6 + 0.4 + 11.0 = 58.7 \text{ t}$$

b) Up lift U

Up lift U is calculated as below.

$$U = \gamma_w \cdot h_w \cdot A = 1.0 \times 8.8 \times 5.2 \times 1.0 = 45.8 \text{ t}$$

c) Checking on the safety factor of floating F_1

The safety factor of floating F_1 is checked by the follwing two cases.

i) at normal

$$F_{11} = \frac{V_1}{U} = \frac{68.0}{45.8} = 1.48 \underset{O.K}{>} 1.1$$

ii) at construction

$$F_{12} = \frac{V_2}{U} = \frac{58.7}{45.8} = 1.28 \underset{O.K}{>} 1.0$$

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1.4 設計ケース

次の３ケースが構造設計計算として考えられる。

Table 2. Summary of design cases

CASE	1	2	3
CONDITION	at Normal	at Earthquake	at Construction
Earthquake	None	Considered	None
Water Content	L.L.W.L	L.L.W.L	Empty
Self weight	Considered	Considered	Considered
The surcharge load	Considered	Considered	Considered
The increment ratio of the allowable stress	1.0	1.5	1.25

1.5 構造設計

1.5.1 荷重ケース1（常時、長期）

1) 設計構造物の骨格

Frame of the design structure is shown in Fig 6, and the design structure is considered for the rigid frame structure.

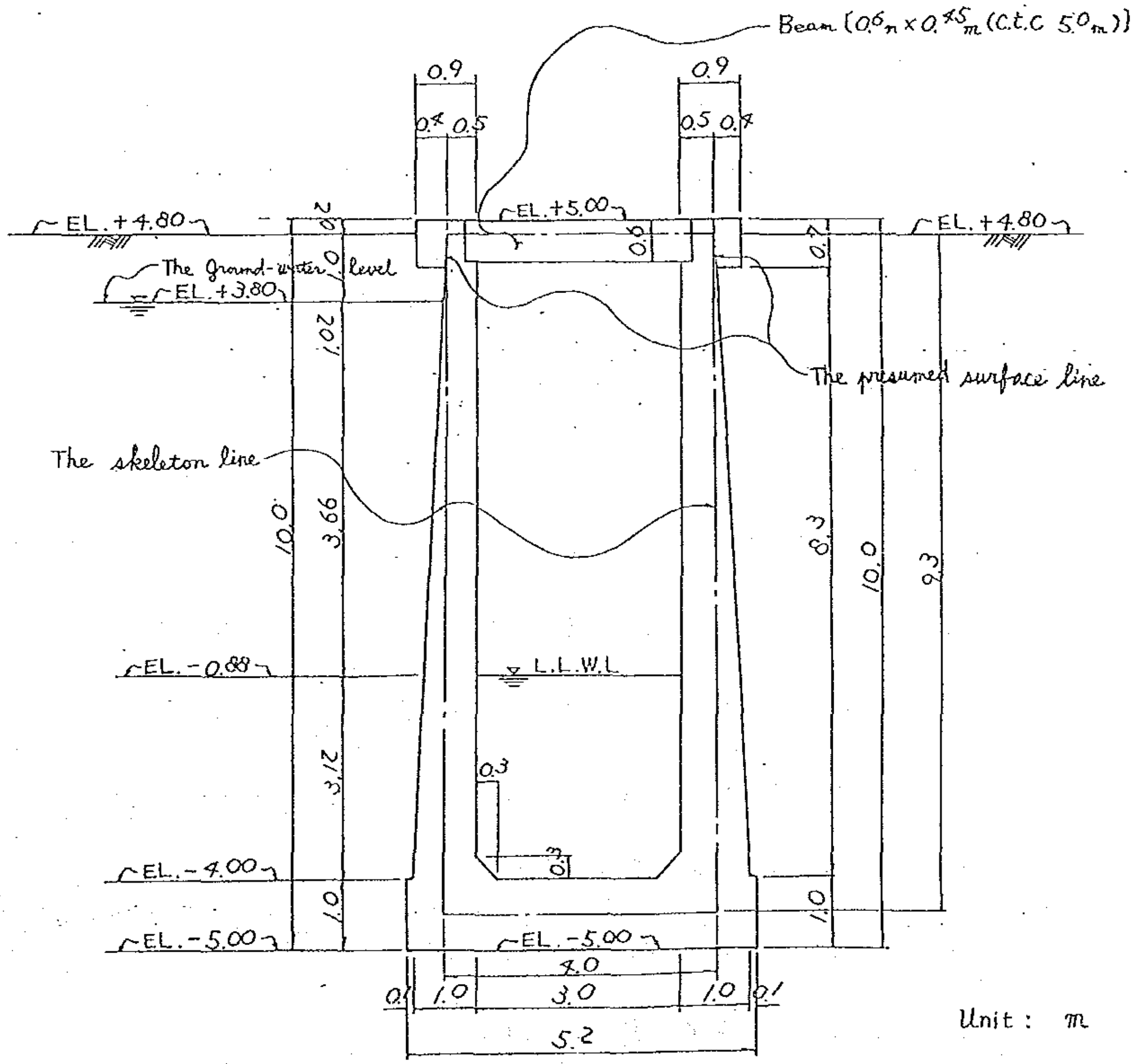

Fig 6. Frame of the design structure

2) 荷重計算（単位奥行き長さ1m 当り）

a) Surcharge load at the ground level q　　$q = 1.0\ t/m^2$

b) Self weight

i) Side wall W_{c1} (at one side)

$$W_{c1} = \frac{1}{2} \times (0.5 + 1.0) \times 2.45 = 1.84\ t/m^2$$

ii) Base slab W_{c2} (at one side)

$$W_{c2} = 1.0 \times 2.45 = 2.45\ t/m^2$$

iii) Beam

$$W_{c3} = 0.6 \times 0.45 \times 2.45 \div 5.0 = 0.13\ t/m^2$$

c) The earth pressure and the water pressure

i) the earth pressures

$$P_0 = k \cdot q = 0.5 \times 1.0 = 0.5\ t/m^2$$

$$P_1 = k(\gamma h_1 + q) = 0.5 \times (1.9 \times 1.0 + 1.0) = 1.45\ t/m^2$$

$$P_2 = 1.45 + k \cdot \gamma \cdot h_2 = 1.45 + 0.5 \times 1.0 \times 8.3 = 5.60\ t/m^2$$

ii) the water pressure (outside)

$$P_{w0} = \gamma_w \cdot h_{w0} = 1.0 \times 8.3 = 8.3\ t.m^2$$

iii) the water pressure (inside)

$$P_{wi} = \gamma_w \cdot h_{wi} = 1.0 \times 3.12 = 3.12\ t/m^2$$

iv) up lift

$$P_u = \gamma_w \cdot H_w = 1.0 \times 8.8 = 8.8\ t/m^2$$

d) The ground reaction

$$q_r = 11.5\ t/m^2$$

According to the above calculations, the results of load calculations are shown in Fig 7.

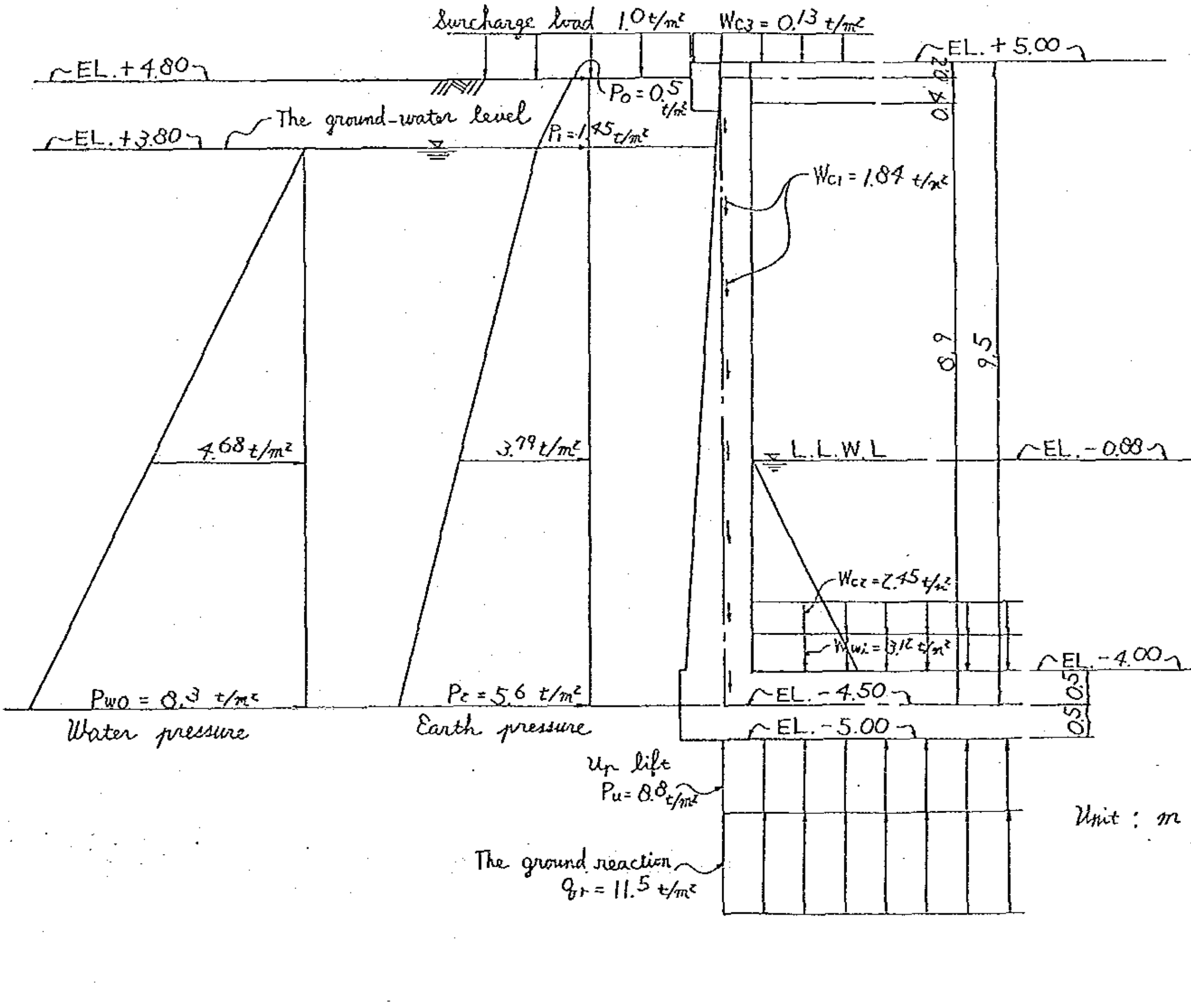

Fig.7 The results of load calculations

3) 荷重図

The load diagram is shown in Fig 8.

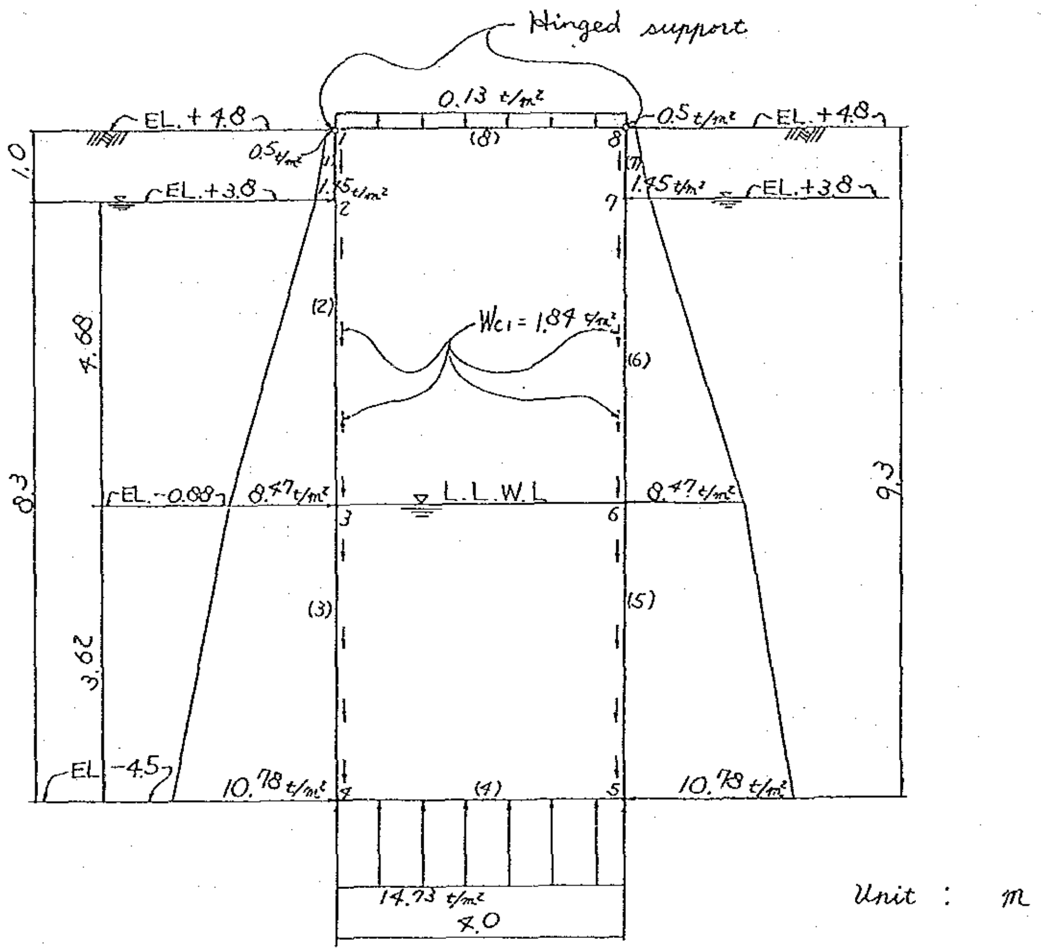

Fig.8 The load diagram

4) 断面諸元に於ける入力データ

The sectional forces are calculated by computer, so input data for the sectional dimensions are indicated in Table 3.

Table 3. Table of the sectional dimensions (per 1 m unit length)

Member's number	Section area A (m^2)	Geometrical moment of inertia I(m^4)	Remarks
(1)	0.53	0.0129	Side wall
(2)	0.68	0.0262	Side wall
(3)	0.90	0.0608	Side wall
(4)	1.0	0.0833	Footing
(5)	0.90	0.0608	Side wall
(6)	0.68	0.0262	Side wall
(7)	0.53	0.0129	Side wall
(8)	0.054	0.0016	beam @ 5.0 m

1.5.2 荷重ケース２（地震時、短期）

1) 設計構造

Design structure is shown in Fig 9.

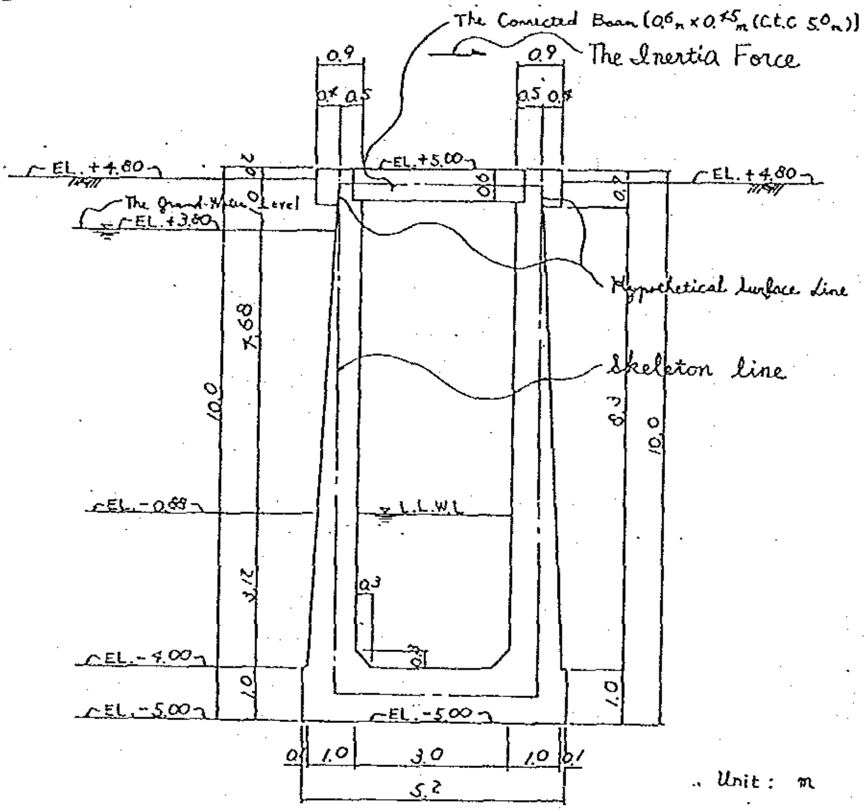

Fig.9 Design structure

2) 荷重計算（単位奥行き長さ１ｍ当り）

a) The ground surface surcharge

$q = 1.0\ t/m^2$

b) Self weight

i) side wall $W_{c1} = 1.84\ t/m^2$ (at one side)

ii) base slab $W_{c2} = 2.45\ t/m^2$ (at one side)

iii) beam $W_{c3} = 0.13\ t/m^2$

iv) water weight $W_w = 1.0 \times 3.12 = 3.12\ t/m^2$

c) The force of inertia

Design seismic coefficient $k_h = 0.10$, so the force of inertia is calculated as below.

i) side wall (at one side)

$W_{ch1} = k_h \cdot W_{c1} = 0.1 \times 1.84 = 0.18\ t/m^2$

ii) base slab (at one side)

$W_{ch2} = k_h \cdot W_{c2} = 0.1 \times 2.45 = 0.25\ t/m^2$

iii) beam

$W_{ch3} = k_h \cdot W_{c3} = 0.1 \times 0.13 = 0.01\ t/m^2$

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d) The seismic earth pressures and the water pressures

i) the seismic earth pressures

The coefficient of seismic active pressure is calculated by the following equations.

$$Kea \fallingdotseq \frac{\cos^2(\phi - \theta_0 - \theta)}{\cos\theta_0 \cdot \cos^2\theta \cdot \cos(\theta + \theta_0 + \delta)\left\{1 + \sqrt{\dfrac{\sin(\phi+\delta)\sin(\phi-\delta-\theta_0)}{\cos(\theta+\theta_0+\delta)\cos(\theta-\alpha)}}\right\}^2}$$

Where ϕ : the angle of the internal friction = 27°

α : the angle between the ground surface and the horizontal plane $\alpha = 0°$

θ : the angle between the back wall surface and the vertical plane

$$\theta = \tan^{-1}\frac{0.5}{8.97} \fallingdotseq 3°$$

δ : the angle of the wall surface friction between the back wall surface and back−fill $\delta = 0°$

θ_0 : the composite angle of earthquake

$$\theta_0 = \tan^{-1}k_h = \tan^{-1}0.1 \fallingdotseq 5.7°$$

Therefore

$$Kea = \frac{\cos^2(27° - 5.7° - 3°)}{\cos5.7° \times \cos^2 3° \times \cos(3° + 5.7°) \times \left\{1 + \sqrt{\dfrac{\sin27° \cdot \sin(27° - 5.7°)}{\cos(3° + 5.7°) \cdot \cos3°}}\right\}^2}$$

$= 0.463$

The seismic passive earth pressure is determined by balancing the force which is figured out by the inertia forces and the seismic active earth pressures.
Accordingly the seismic earth pressures are calculated as follows.

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ii) the active earth pressures (Horizontal)

(Horizontal)

$P_{EAh0} = K_{EA} \cdot \cos 3° \cdot q = 0.463 \times 0.999 \times 1.0 = 0.46\ t/m^2$

$P_{EAh1} = 0.463 \times 0.999 \times (1.0 + 1.9 \times 1.0) = 1.34\ t/m^2$

$P_{EAh2} = 0.463 \times 0.999 \times (1.0 + 1.9 \times 1.0 + 1.0 \times 8.3) = 5.18\ t/m^2$

(Vertical)

$P_{EAv0} = K_{EA} \cdot \sin 3° \cdot q = 0.463 \times 0.052 \times 1.0 = 0.02\ t/m^2$

$P_{EAv1} = 0.463 \times 0.052 \times (1.0 + 1.9 \times 1.0) = 0.07\ t/m^2$

$P_{EAv2} = 0.463 \times 0.052 \times (1.0 + 1.9 \times 1.0 + 1.0 \times 8.3) = 0.27\ t/m^2$

iii) the passive earth pressures

Total passive pressures are balanced to total horizontal forces, so they are calculated as below.

(Horizontal)	(Vertical)
$P_{EPh0} = 0.95\ t/m2$	$P_{EPv0} = P_{EPh0} \cdot \tan 3° = 0.95 \times 0.052 = 0.05\ t/m^2$
$P_{EPh1} = 1.70\ t/m^2$	$P_{EPv1} = P_{EPv1} \cdot \tan 3° = 1.70 \times 0.052 = 0.09\ t/m^2$
$P_{EPh2} = 5.78\ t/m^2$	$P_{EPv2} = P_{EPv2} \cdot \tan 3° = 5.78 \times 0.052 = 0.30\ t/m^2$

iv) the static water pressure

The static water pressures are calculated by dividing between inside and outside.

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(Inside)

$$P_{wi} = \gamma_w \cdot h_i = 1.0 \times 3.12 = 3.12 \ t/m^2$$

(Outside)

$$P_{wo} = \gamma_w \cdot h_o = 1.0 \times 8.3 = 8.3 \ t/m^2$$

v) the dynamic water pressure

The dynamic water pressure is considered for working to side walls, therefore dynamic water pressure is calculated as below.

$$P_{ew} = \frac{7}{12} \cdot K_h \cdot \gamma_w \cdot b \cdot h^2 = \frac{7}{12} \times 0.1 \times 1.0 \times 1.0 \times 3.12^2 = 0.57 \ t$$

Working point of Pew (h_{ew})

$$h_{ew} = \frac{h}{2} + 0.5 = \frac{3.12}{2} + 0.5 = 2.06 \ m$$

vi) up lift

$$P_u = \gamma w \cdot H_w = 1.0 \times (8.3 + 0.5) = 8.8 \ t/m^2$$

e) The ground reaction

$$q_r = 11.5 \ t/m_2$$

1121

f) The results of load calculations

The results of load calculations are shown in Fig 10.

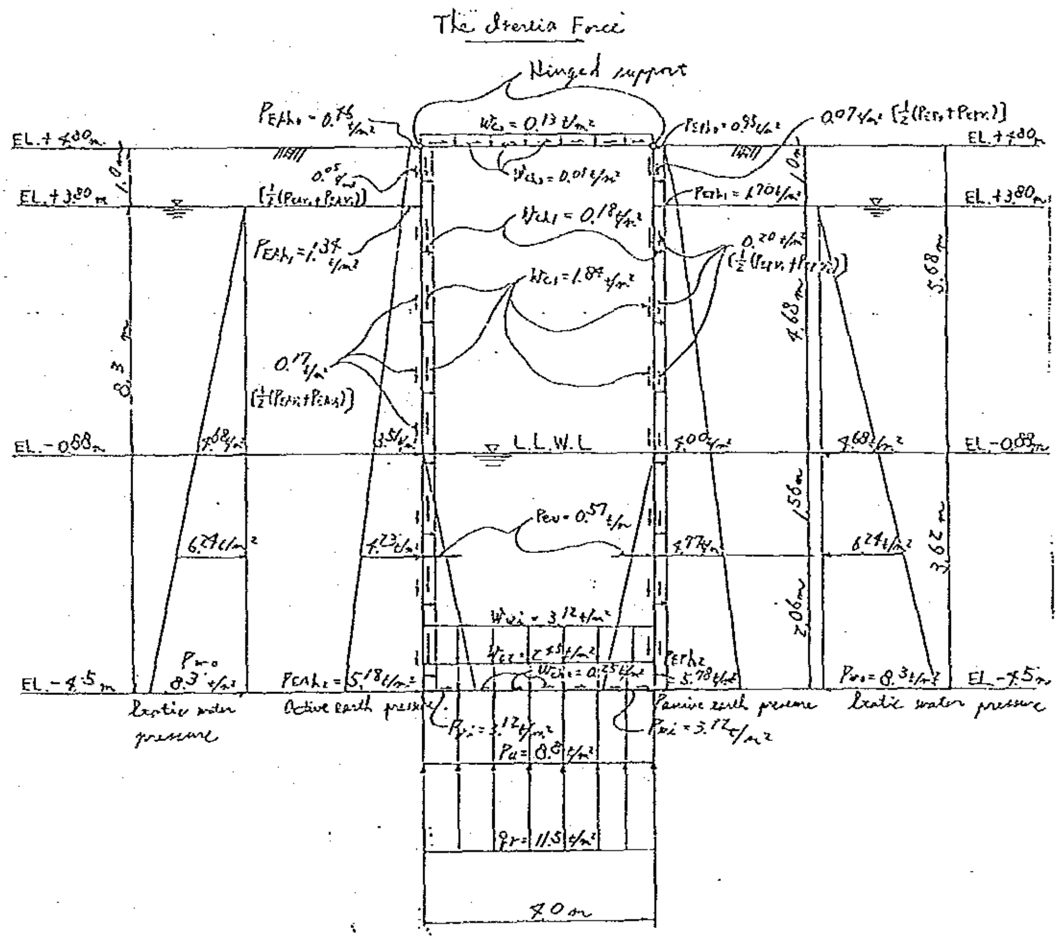

Fig.10 The results of load calculations

3) 荷 重 図

The load diagram is shown in Fig 11.

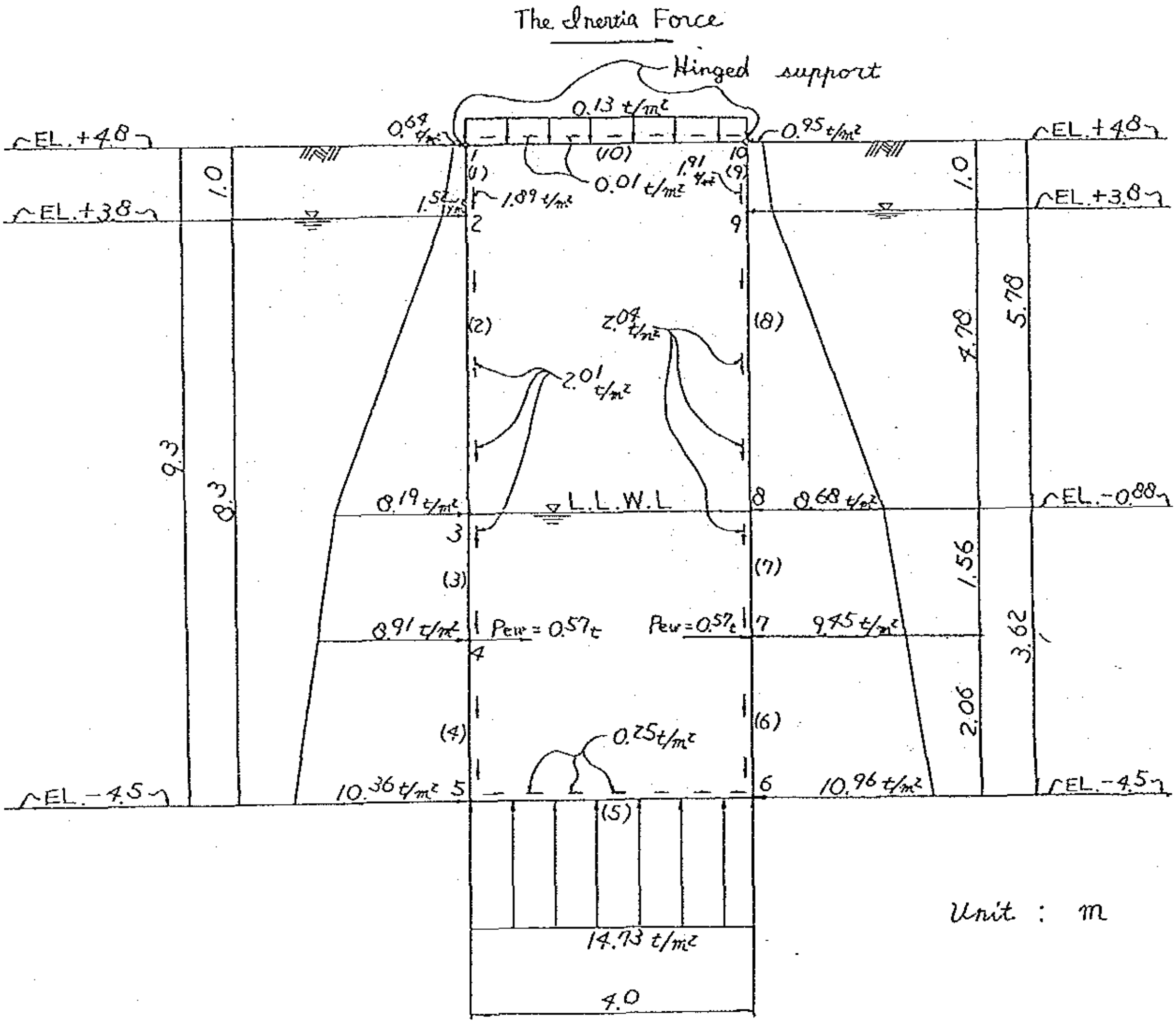

Fig.11 The load diagram

4) 断面諸元に於ける入力データ 1

a) The sectional dimensions

Table 4. Table of the sectional dimensions (per 1 m unit length)

Member's number	Section Area A (m^2)	Geometrical moment of inertia I (m^4)	Remarks
(1)	0.53	0.013	Side wall
(2)	0.68	0.026	Side wall
(3)	0.85	0.051	Side wall
(4)	0.95	0.071	Side wall
(5)	1.00	0.083	Footing
(6)	0.95	0.071	Side wall
(7)	0.85	0.051	Side wall
(8)	0.68	0.026	Side wall
(9)	0.53	0.013	Side wall
(10)	0.054	0.0016	Beam @ 5.0m

1.5.3 荷重ケース３（施工時、短期）

1) 設計構造ructure

Design structure is shown in Fig 12.

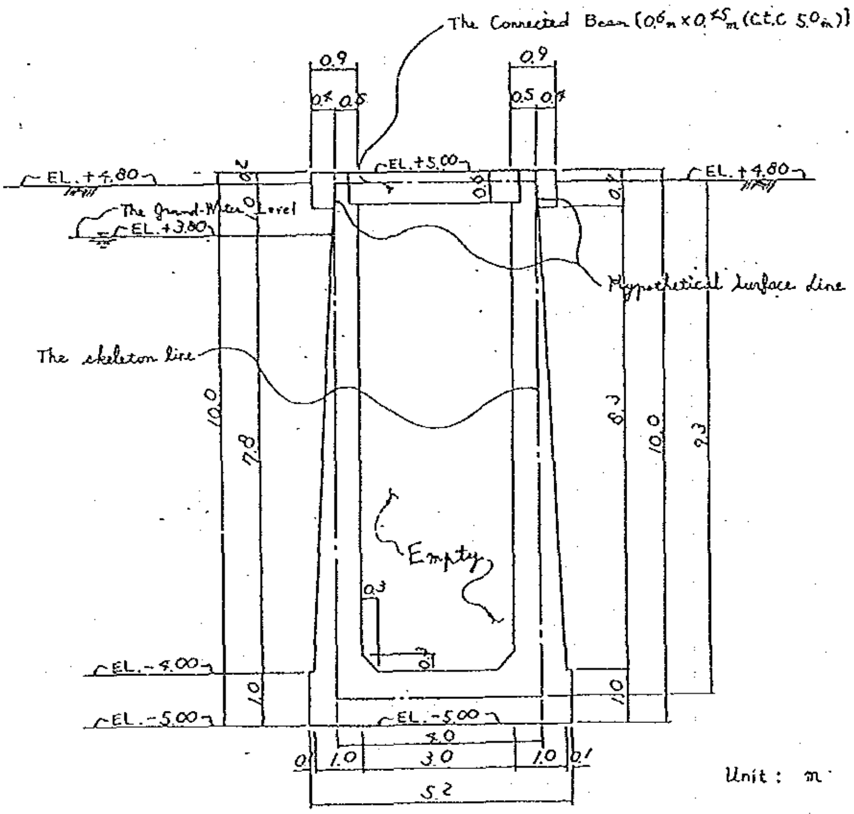

Fig 12. Design structure

2) 荷重計算（単位奥行き長さ１ｍ 当り)ngth)

The process and the results of load calculations are the same as Case−1 excluding a calculation of inside water load.
In this design case the inside water pressure and the inside water weight is no considered(= 0).

3) 荷重図

The load diagram is shown in Fig 13.

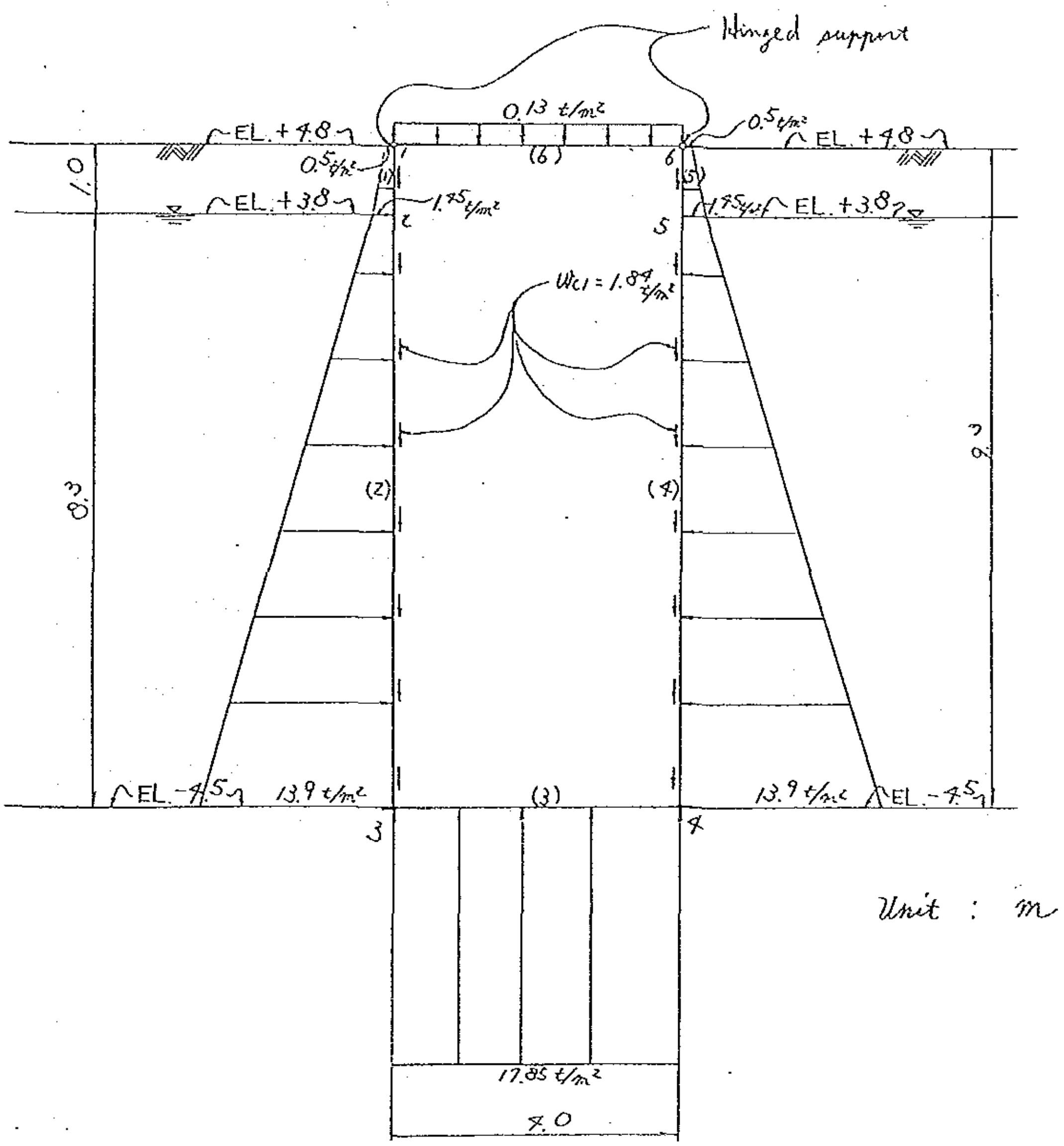

Fig 13. The load diagram

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4) 断面諸元に於ける入力データ

The sectional forces are calculated by computer, so input data for the sectional dimensions are indicated in Table 5.

Table 5. Table of the sectional dimensions (per 1 m unit length)

Member's number	Section area A (m^2)	Geometrical moment of inertia I (m^4)	Remarks
(1)	0.53	0.0129	Side wall
(2)	0.79	0.0411	Side wall
(3)	1.0	0.0833	Footing
(4)	0.79	0.0411	Side wall
(5)	0.53	0.0129	Side wall
(6)	0.054	0.0016	Beam @ 5.0 m

SHEET ______ OF ______

Case - 1 (at Normal)

FORM 04

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1.5.4 電算による計算結果

電算による計算結果は、曲げモーメント，せん断力，軸力であり、それらは後の図に示されている。今、3つの荷重ケースを比較すると、断面力はどのケースともほぼ同じであり、安全設計の観点から、常時の断面力が断面応力の計算に採用される。

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INTAKE OPEN CHANNEL CASE-1 (NORMAL, L.L.W.L)

BENDING MOMENT

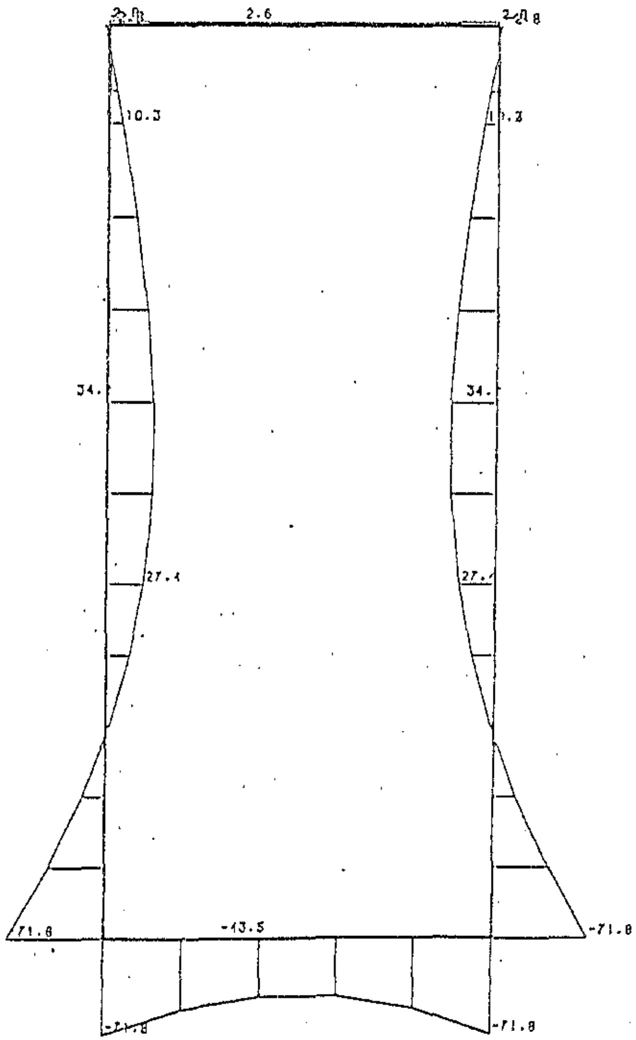


Fig 14. The bending moment diagram

SHEET ______ OF ______

Case - 2 (at Earthquake)

FORM 04

1130

29-1

INTAKE OPEN CHANNEL CASE-1 (NORMAL, L.L.W.L)

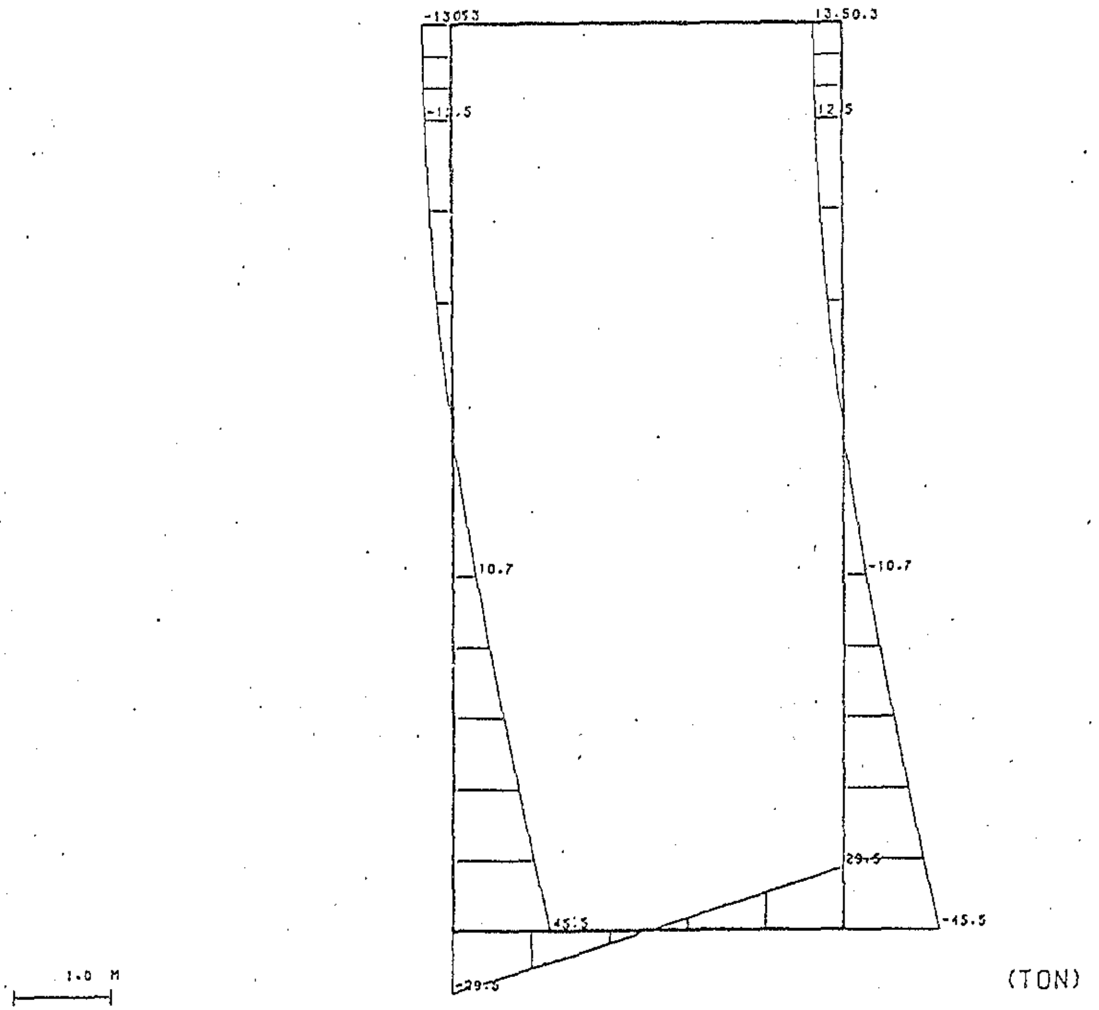
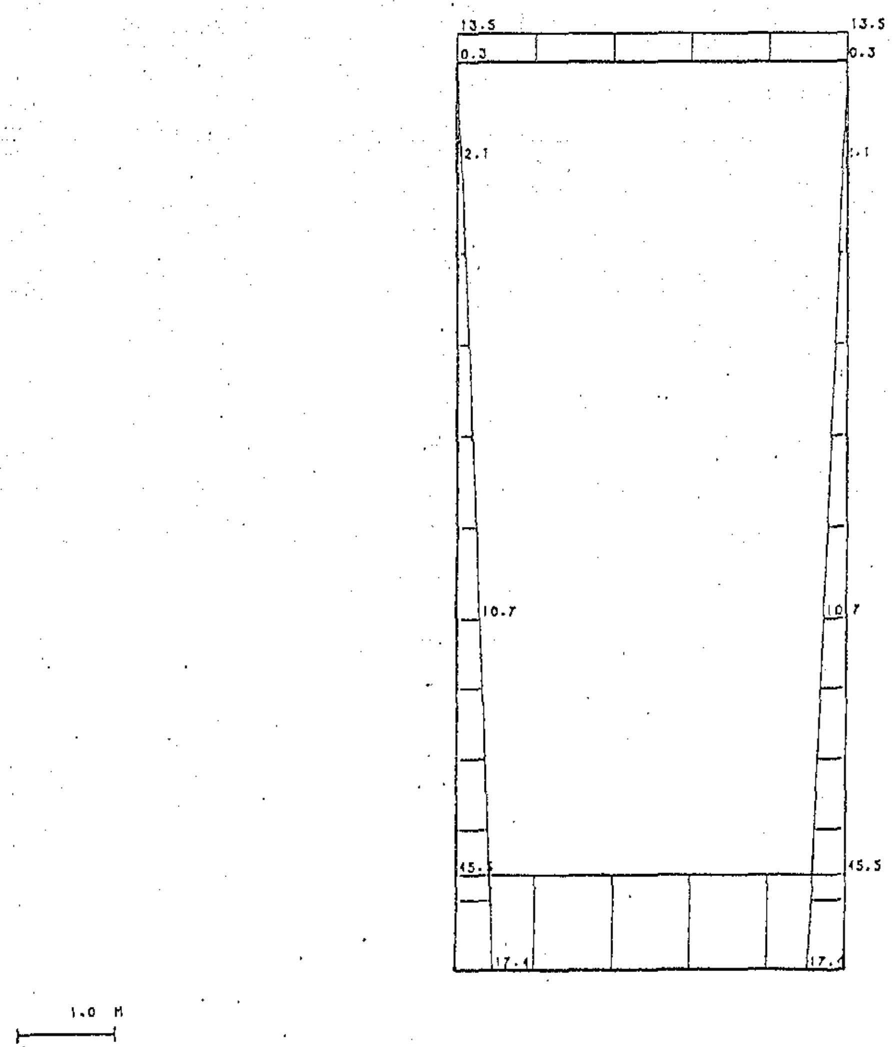


Fig 15. The shearing force diagram

1131

INTAKE OPEN CHANNEL CASE-1 (NORMAL, L.L.W.L)

AXIAL FORCE



(TON)

Fig 16. The axial force diagram

Table 6. Summary of the sectional forces (Normal)

** ELEMENTAL FORCES **

ELEM	I-END	AXIAL	SHEAR	MOMENT	J-END	AXIAL	SHEAR	MOMENT
1	1	2.6000E-01	-1.3504E+01	-2.8329E+00	11	8.7327E-01	-1.3284E+01	1.6349E+00
2	11	8.7327E-01	-1.3284E+01	1.6343E+00	12	1.4867E+00	-1.2959E+01	6.0126E+00
3	12	1.4867E+00	-1.2959E+01	6.0120E+00	2	2.1000E+00	-1.2529E+01	1.0263E+01
4	2	2.1000E+00	-1.2529E+01	1.0263E+01	13	3.8222E+00	-1.0514E+01	2.1170E+01
5	13	3.8222E+00	-1.0514E+01	2.1149E+01	14	5.5445E+00	-7.1860E+00	2.9556E+01
6	14	5.5445E+00	-7.1860E+00	2.9536E+01	15	7.2667E+00	-2.5435E+00	3.4212E+01
7	15	7.2667E+00	-2.5435E+00	3.4191E+01	16	8.9890E+00	3.4132E+00	3.3907E+01
8	16	8.9890E+00	3.4132E+00	3.3887E+01	3	1.0711E+01	1.0684E+01	2.7412E+01
9	3	1.0711E+01	1.0684E+01	2.7392E+01	17	1.2043E+01	1.6984E+01	1.7400E+01
10	17	1.2043E+01	1.6984E+01	1.7396E+01	18	1.3376E+01	2.3618E+01	2.7229E+00
11	18	1.3376E+01	2.3618E+01	2.7189E+00	19	1.4708E+01	3.0586E+01	-1.6879E+01
12	19	1.4708E+01	3.0586E+01	-1.6883E+01	20	1.6040E+01	3.7889E+01	-4.1646E+01
13	20	1.6040E+01	3.7889E+01	-4.1651E+01	4	1.7372E+01	4.5527E+01	-7.1823E+01
14	4	4.5527E+01	-2.9460E+01	-7.1827E+01	21	4.5527E+01	-1.7676E+01	-5.2972E+01
15	21	4.5527E+01	-1.7676E+01	-5.2972E+01	22	4.5527E+01	-5.8920E+00	-4.3545E+01
16	22	4.5527E+01	-5.8920E+00	-4.3545E+01	23	4.5527E+01	5.8920E+00	-4.3545E+01
17	23	4.5527E+01	5.8920E+00	-4.3545E+01	24	4.5527E+01	1.7676E+01	-5.2972E+01
18	24	4.5527E+01	1.7676E+01	-5.2972E+01	5	4.5527E+01	2.9460E+01	-7.1827E+01
19	5	1.7372E+01	-4.5527E+01	-7.1827E+01	25	1.6040E+01	-3.7889E+01	-4.1655E+01
20	25	1.6040E+01	-3.7889E+01	-4.1651E+01	26	1.4708E+01	-3.0586E+01	-1.6887E+01
21	26	1.4708E+01	-3.0586E+01	-1.6883E+01	27	1.3376E+01	-2.3618E+01	2.7149E+00
22	27	1.3376E+01	-2.3618E+01	2.7189E+00	28	1.2043E+01	-1.6984E+01	1.7392E+01
23	28	1.2043E+01	-1.6984E+01	1.7396E+01	6	1.0711E+01	-1.0684E+01	2.7388E+01
24	6	1.0711E+01	-1.0684E+01	2.7392E+01	29	8.9890E+00	-3.4132E+00	3.3866E+01
25	29	8.9890E+00	-3.4132E+00	3.3887E+01	30	7.2667E+00	2.5435E+00	3.4171E+01
26	30	7.2667E+00	2.5435E+00	3.4191E+01	31	5.5445E+00	7.1860E+00	2.9515E+01
27	31	5.5445E+00	7.1860E+00	2.9536E+01	32	3.8222E+00	1.0514E+01	2.1129E+01
28	32	3.8222E+00	1.0514E+01	2.1149E+01	7	2.1000E+00	1.2529E+01	1.0242E+01
29	7	2.1000E+00	1.2529E+01	1.0263E+01	33	1.4867E+00	1.2959E+01	6.0114E+00
30	33	1.4867E+00	1.2959E+01	6.0120E+00	34	8.7327E-01	1.3284E+01	1.6337E+00
31	34	8.7327E-01	1.2284E+01	1.6343E+00	8	2.6000E-01	1.3504E+01	-2.8334E+00
32	1	1.3504E+01	2.6000E-01	2.8329E+00	35	1.3504E+01	1.5600E-01	2.6665E+00
33	35	1.3504E+01	1.5600E-01	2.6665E+00	36	1.3504E+01	5.2000E-02	2.5833E+00
34	36	1.3504E+01	5.2000E-02	2.5833E+00	37	1.3504E+01	-5.2000E-02	2.5833E+00
35	37	1.3504E+01	-5.2000E-02	2.5833E+00	38	1.3504E+01	-1.5600E-01	2.6665E+00
36	38	1.3504E+01	-1.5600E-01	2.6665E+00	8	1.3504E+01	-2.6000E-01	2.8329E+00

9/33

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INTAKE OPEN CHANNELCASE-2 (EARTHQUAKE, L. L. W. L)

BENDING MOMENT

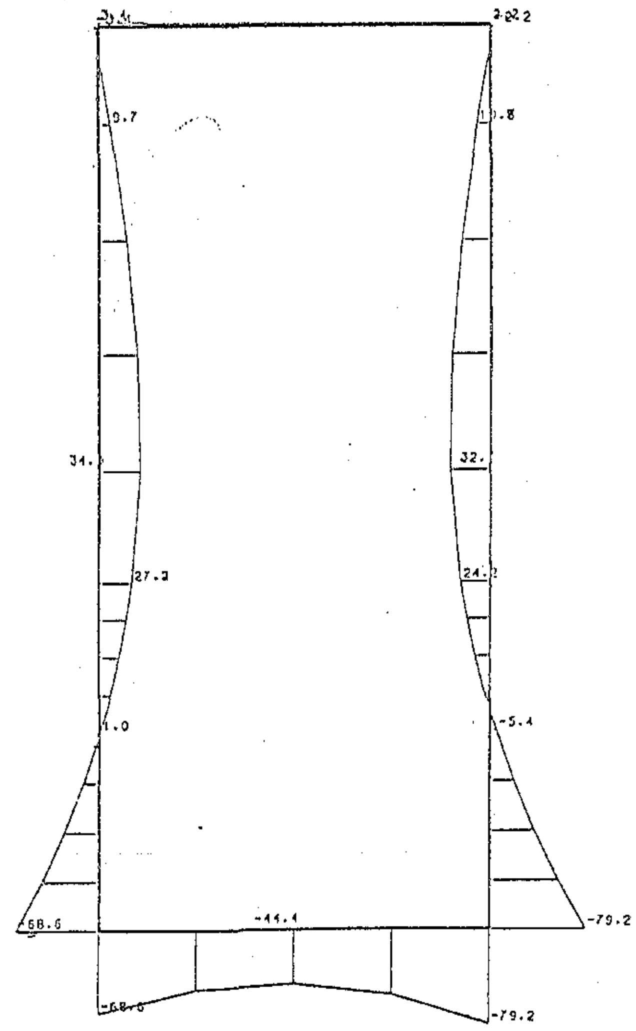

Fig 17. The bending moment diagram

INTAKE OPEN CHANNELCASE-2 (EARTHQUAKE, L. L. W. L)

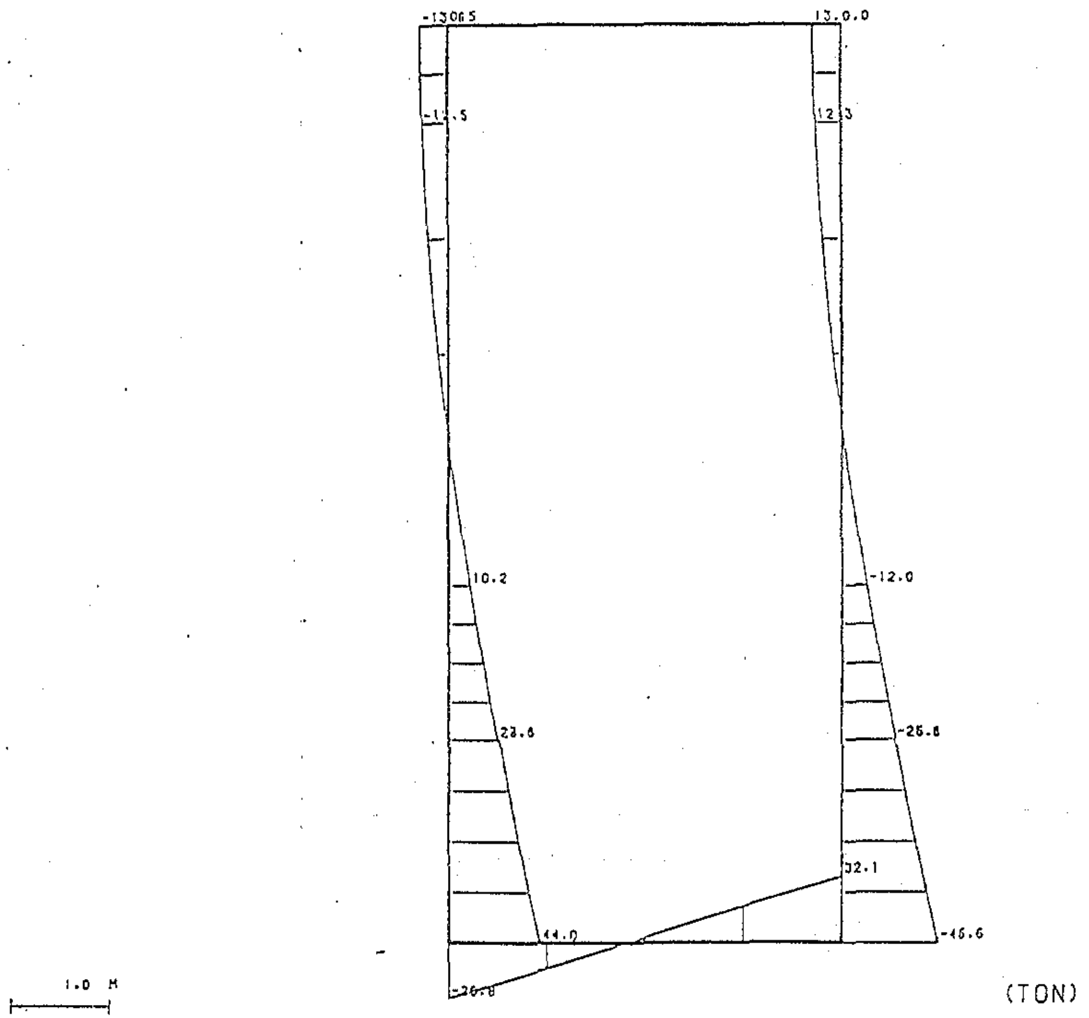

Fig 18. The shearing force diagram

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INTAKE OPEN CHANNELCASE-2 (EARTHQUAKE, L. L. W. L)

AXIAL FORCE

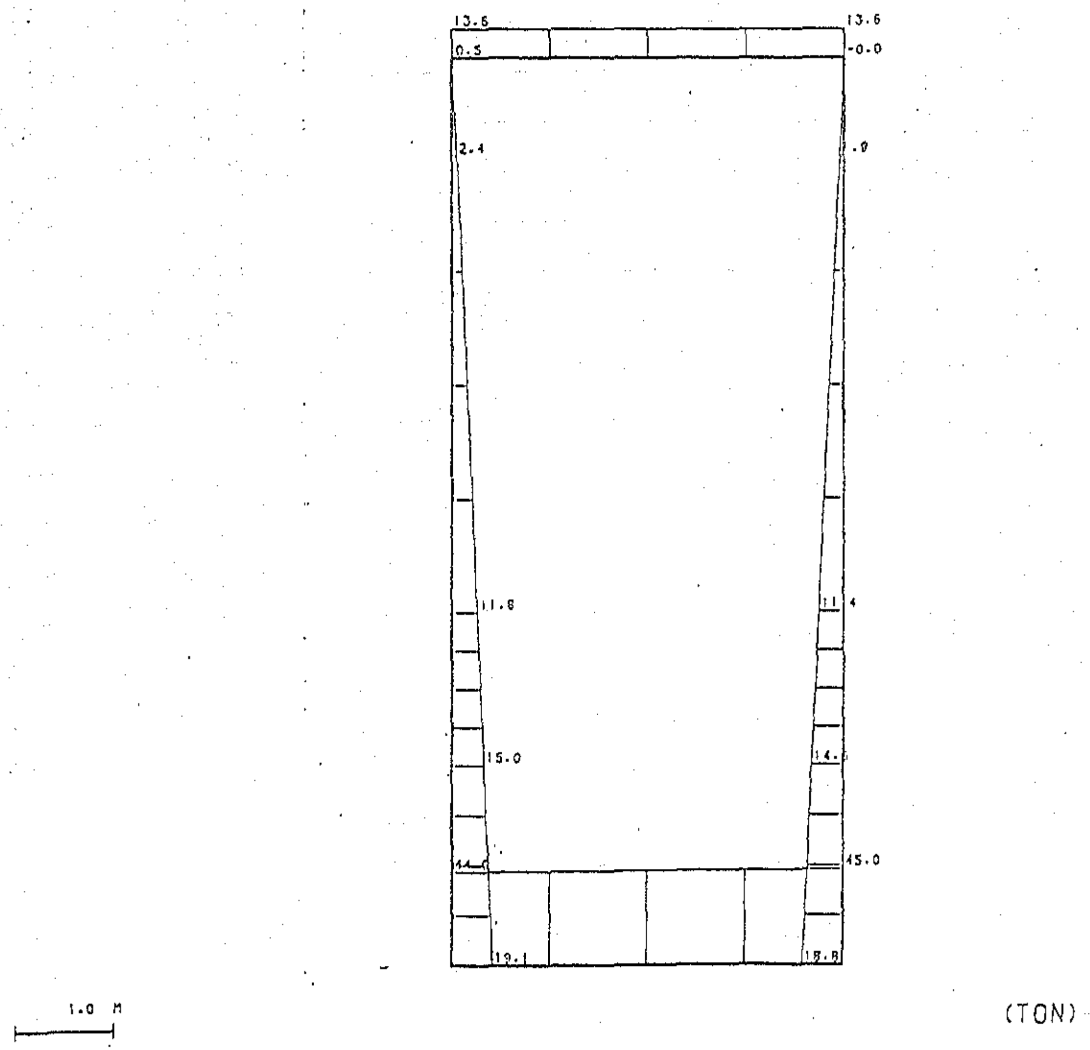

Fig 19. The axial force diagram

Table 7. Summary of the sectional forces (Earthquake)

** ELEMENTAL FORCES **

ELEM	I-END	AXIAL	SHEAR	MOMENT	J-END	AXIAL	SHEAR	MOMENT
1	1	5.4210E-01	-1.3579E+01	-3.3665E+00	13	1.4871E+00	-1.3149E+01	3.3263E+00
2	13	1.4871E+00	-1.3149E+01	3.3244E+00	2	2.4321E+00	-1.2499E+01	9.7472E+00
3	2	2.4321E+00	-1.2499E+01	9.7454E+00	14	4.7838E+00	-9.7447E+00	2.2986E+01
4	14	4.7838E+00	-9.7447E+00	2.2948E+01	15	7.1355E+00	-5.0399E+00	3.1825E+01
5	15	7.1355E+00	-5.0399E+00	3.1787E+01	16	9.4872E+00	1.6160E+00	3.4018E+01
6	16	9.4872E+00	1.6160E+00	3.3980E+01	3	1.1839E+01	1.0223E+01	2.7283E+01
7	3	1.1839E+01	1.0223E+01	2.7245E+01	17	1.2623E+01	1.3452E+01	2.2631E+01
8	17	1.2623E+01	1.3452E+01	2.2631E+01	18	1.3407E+01	1.6751E+01	1.6744E+01
9	18	1.3407E+01	1.6751E+01	1.6743E+01	19	1.4191E+01	2.0121E+01	9.5558E+00
10	19	1.4191E+01	2.0121E+01	9.5554E+00	4	1.4975E+01	2.3561E+01	1.0402E+00
11	4	1.4975E+01	2.4131E+01	1.0397E+00	20	1.6010E+01	2.8813E+01	-1.2584E+01
12	20	1.6010E+01	2.8813E+01	-1.2585E+01	21	1.7045E+01	3.3681E+01	-2.8668E+01
13	21	1.7045E+01	3.3681E+01	-2.8670E+01	22	1.8080E+01	3.8737E+01	-4.7308E+01
14	22	1.8080E+01	3.8737E+01	-4.7309E+01	5	1.9115E+01	4.3979E+01	-6.8599E+01
15	5	4.3979E+01	-2.6821E+01	-6.8601E+01	23	4.4229E+01	-1.2091E+01	-4.9145E+01
16	23	4.4229E+01	-1.2091E+01	-4.9145E+01	24	4.4479E+01	2.6390E+00	-4.4419E+01
17	24	4.4479E+01	2.6390E+00	-4.4419E+01	25	4.4729E+01	1.7369E+01	-5.4423E+01
18	25	4.4729E+01	1.7369E+01	-5.4423E+01	6	4.4979E+01	3.2099E+01	-7.9157E+01
19	6	1.8820E+01	-4.6589E+01	-7.9157E+01	26	1.7769E+01	-4.1042E+01	-5.6601E+01
20	26	1.7769E+01	-4.1042E+01	-5.6600E+01	27	1.6719E+01	-3.5689E+01	-3.6851E+01
21	27	1.6719E+01	-3.5689E+01	-3.6850E+01	28	1.5668E+01	-3.0531E+01	-1.9808E+01
22	28	1.5668E+01	-3.0531E+01	-1.9806E+01	7	1.4617E+01	-2.5567E+01	-5.3712E+00
23	7	1.4617E+01	-2.6137E+01	-5.3695E+00	29	1.3822E+01	-2.2489E+01	4.1096E+00
24	29	1.3822E+01	-2.2489E+01	4.1101E+00	30	1.3026E+01	-1.8916E+01	1.2181E+01
25	30	1.3026E+01	-1.8916E+01	1.2182E+01	31	1.2231E+01	-1.5418E+01	1.8874E+01
26	31	1.2231E+01	-1.5418E+01	1.8874E+01	8	1.1435E+01	-1.1996E+01	2.4217E+01
27	8	1.1435E+01	-1.1996E+01	2.4218E+01	32	9.0483E+00	-2.8608E+00	3.2670E+01
28	32	9.0483E+00	-2.8608E+00	3.2710E+01	33	6.6615E+00	4.2323E+00	3.1668E+01
29	33	6.6615E+00	4.2323E+00	3.1708E+01	34	4.2747E+00	9.2838E+00	2.3563E+01
30	34	4.2747E+00	9.2838E+00	2.3602E+01	9	1.8879E+00	1.2294E+01	1.0741E+01
31	9	1.8879E+00	1.2294E+01	1.0780E+01	35	9.3290E-01	1.3050E+01	4.4352E+00
32	35	9.3290E-01	1.3050E+01	4.4368E+00	10	-2.2103E-02	1.3619E+01	-2.2397E+00
33	1	1.3579E+01	5.4210E-01	3.3665E+00	36	1.3589E+01	4.1210E-01	2.8894E+00
34	36	1.3589E+01	4.1210E-01	2.8894E+00	37	1.3599E+01	2.8210E-01	2.5423E+00
35	37	1.3599E+01	2.8210E-01	2.5423E+00	38	1.3609E+01	1.5210E-01	2.3252E+00
36	38	1.3609E+01	1.5210E-01	2.3252E+00	10	1.3619E+01	2.2103E-02	2.2381E+00

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SHEET ______ OF ______

Case - 3 (at Construction)

FORM 04

INTAKE OPEN CHANNEL CASE-3 (CONSTRUCTION, EMPTY)

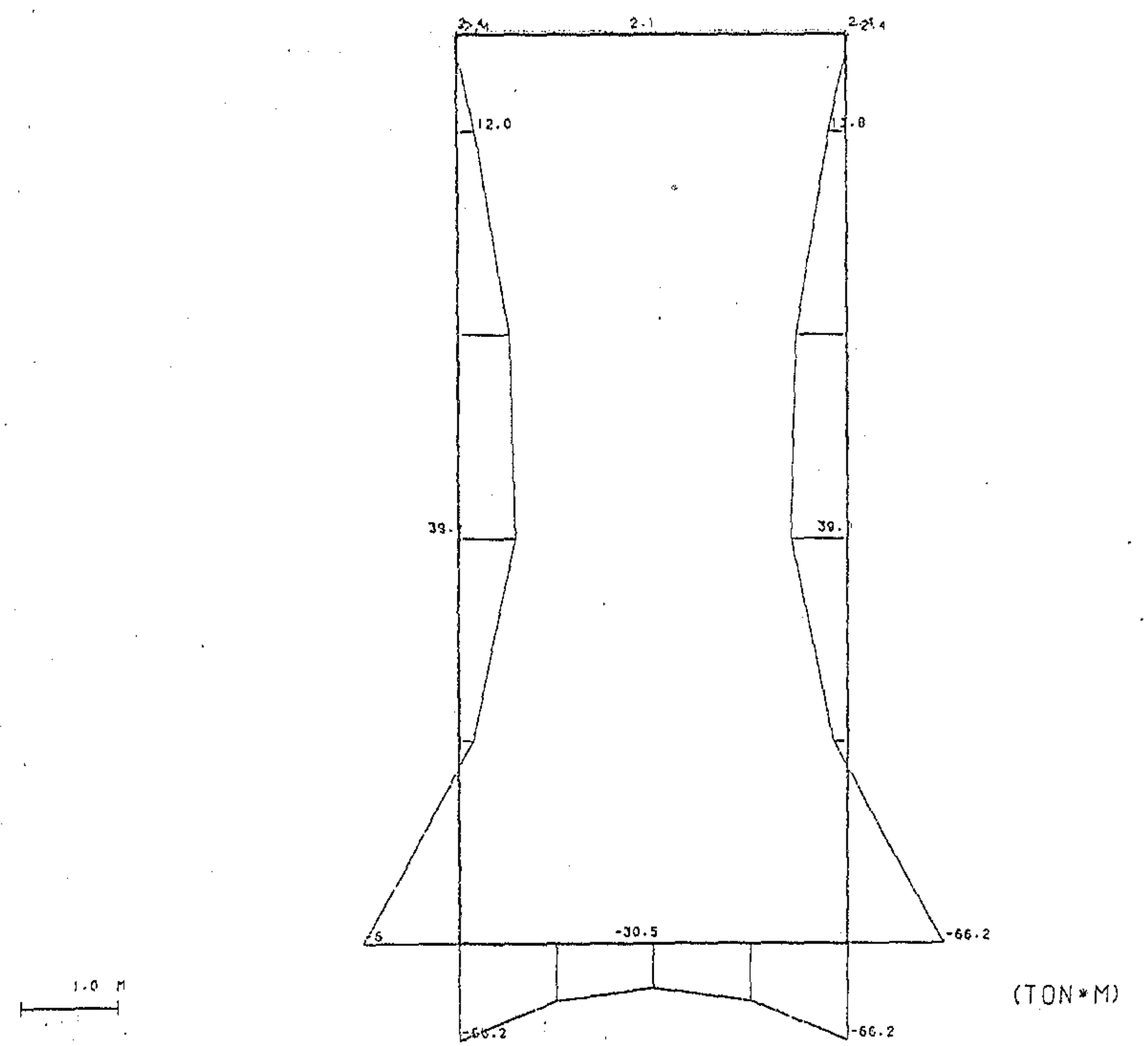

Fig 20. The bending moment diagram

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INTAKE OPEN CHANNEL CASE-3 (CONSTRUCTION, EMPTY)

SHEARING FORCE

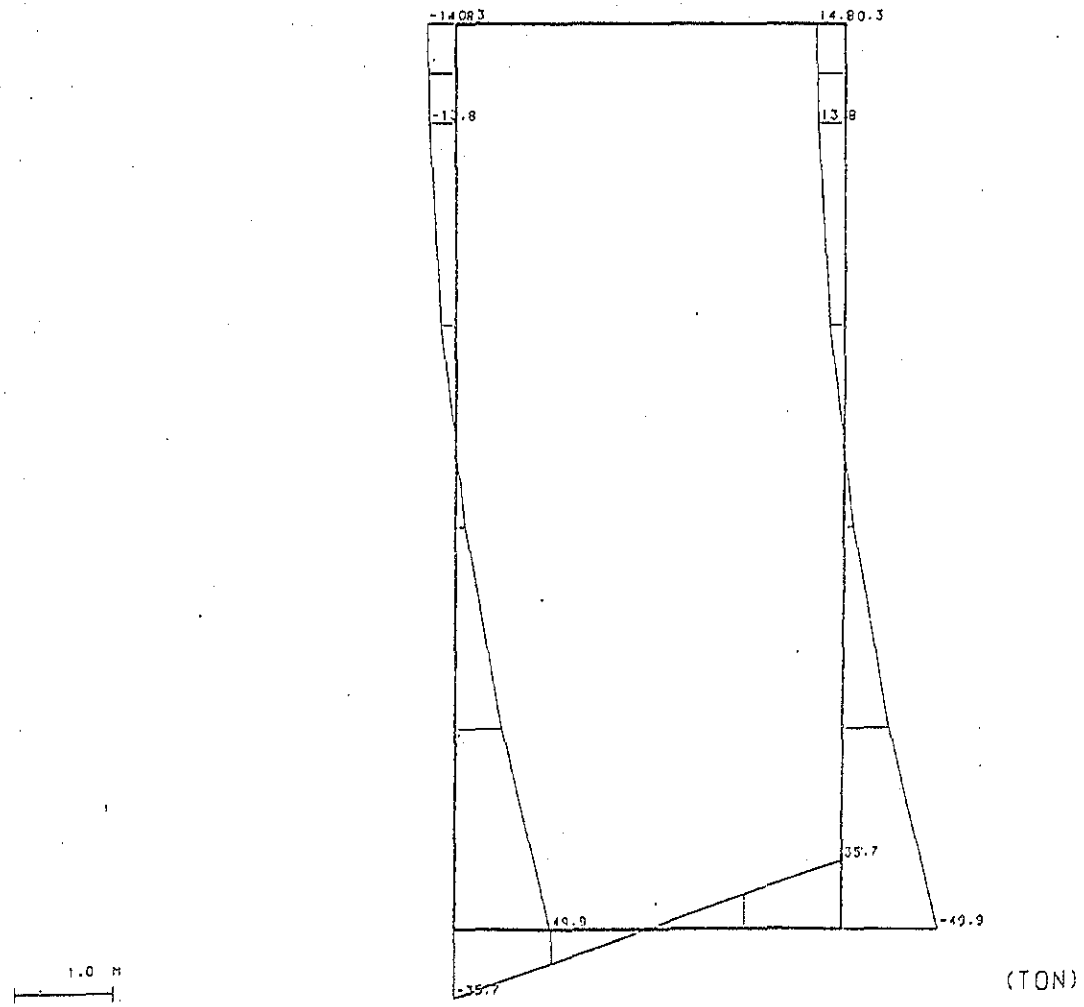

Fig 21. The shearing force diagram

INTAKE OPEN CHANNEL CASE-3 (CONSTRUCTION, EMPTY)

AXIAL FORCE

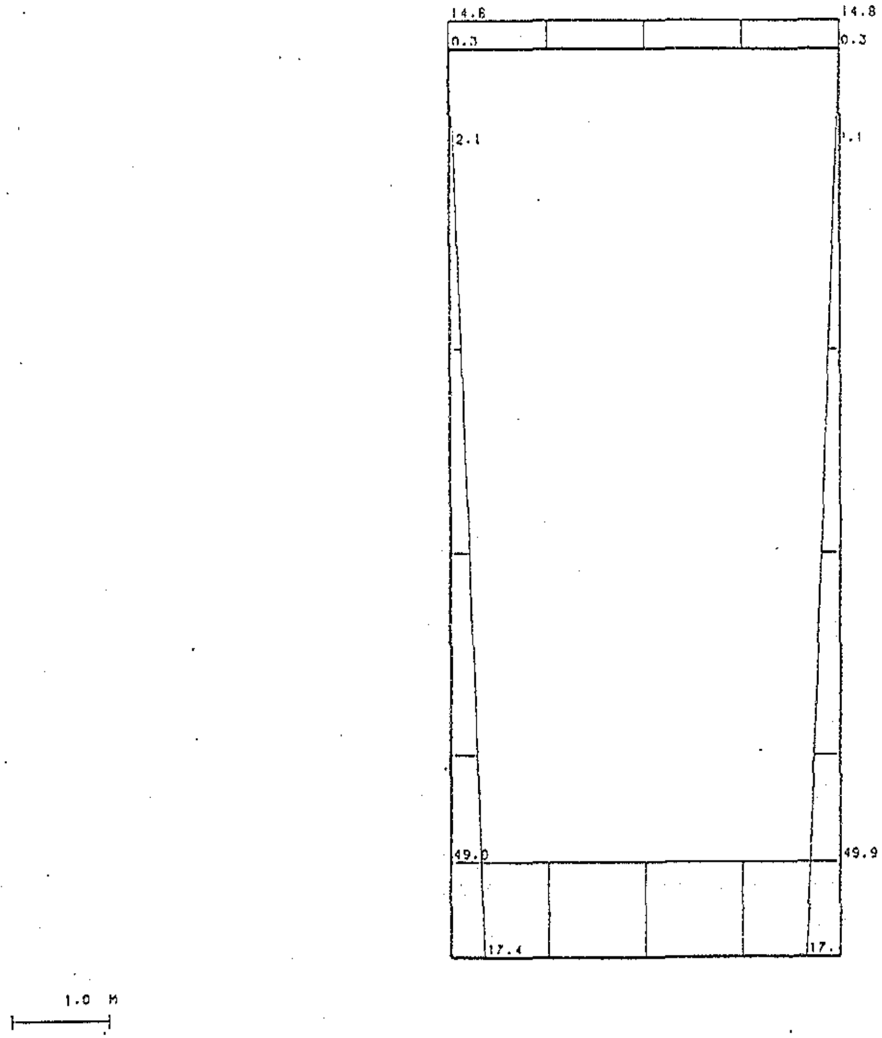

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Fig 22. The axial force diagram

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Table 8. Summary of sectional forces (Construction)

** ELEMENTAL FORCES **

ELEM	I-END	AXIAL	SHEAR	MOMENT	J-END	AXIAL	SHEAR	MOMENT
1	1	2.6000E-01	-1.4799E+01	-2.4035E+00	9	1.1800E+00	-1.4430E+01	4.9156E+00
2	9	1.1800E+00	-1.4430E+01	4.9136E+00	2	2.1000E+00	-1.3824E+01	1.1989E+01
3	2	2.1000E+00	-1.3824E+01	1.1987E+01	10	5.9180E+00	-7.5858E+00	3.5540E+01
4	10	5.9180E+00	-7.5858E+00	3.5316E+01	11	9.7360E+00	5.1106E+00	3.9224E+01
5	11	9.7360E+00	5.1106E+00	3.9001E+01	12	1.3554E+01	2.4265E+01	9.8636E+00
6	12	1.3554E+01	2.4265E+01	9.6402E+00	3	1.7372E+01	4.9879E+01	-6.5944E+01
7	3	4.9879E+01	-3.5700E+01	-6.6168E+01	13	4.9879E+01	-1.7850E+01	-3.9393E+01
8	13	4.9879E+01	-1.7850E+01	-3.9393E+01	14	4.9879E+01	3.5283E-13	-3.0468E+01
9	14	4.9879E+01	4.8406E-13	-3.0468E+01	15	4.9879E+01	1.7850E+01	-3.9393E+01
10	15	4.9879E+01	1.7850E+01	-3.9393E+01	4	4.9879E+01	3.5700E+01	-6.6168E+01
11	4	1.7372E+01	-4.9879E+01	-6.6168E+01	16	1.3554E+01	-2.4265E+01	9.4169E+00
12	16	1.3554E+01	-2.4265E+01	9.6402E+00	17	9.7360E+00	-5.1106E+00	3.8778E+01
13	17	9.7360E+00	-5.1106E+00	3.9001E+01	18	5.9180E+00	7.5858E+00	3.5093E+01
14	18	5.9180E+00	7.5858E+00	3.5316E+01	5	2.1000E+00	1.3824E+01	1.1764E+01
15	5	2.1000E+00	1.3824E+01	1.1987E+01	19	1.1800E+00	1.4430E+01	4.9116E+00
16	19	1.1800E+00	1.4430E+01	4.9136E+00	6	2.6000E-01	1.4799E+01	-2.4055E+00
17	1	1.4799E+01	2.6000E-01	2.4035E+00	20	1.4799E+01	1.3000E-01	2.2085E+00
18	20	1.4799E+01	1.3000E-01	2.2085E+00	21	1.4799E+01	4.4520E-14	2.1435E+00
19	21	1.4799E+01	4.4673E-14	2.1435E+00	22	1.4799E+01	-1.3000E-01	2.2085E+00
20	22	1.4799E+01	-1.3000E-01	2.2085E+00	6	1.4799E+01	-2.6000E-01	2.4035E+00

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