3) Calculation Cases

Table A-5-1 Calculation Cases

Construction Stage		1st Stage	2nd Stage	
Normal/Earthquake		Normal	Normal	Earthquake
Reservoir Water Level		EL. 617.00	EL. 630.00	
Design Loads	Dead load	○		
	Seismic load			○
	Hydrostatic pressure	○	○(differential)	○(differential)
	Hydrodynamic pressure			○
	Uplift	○	○(differential)	○(differential)
	Sediment pressure		○	○
	Decrement of temperature		○	○
Section Forces Stresses		N_1, Q_1, M_1 σ_{c1}, σ_{t1}, τ_1	N_2, Q_2, M_2 σ_{c2}, σ_{t2}, τ_2	N_2', Q_2', M_2' σ_{c2}', σ_{t2}', τ_2'
Cumulative Section Forces		N_1 Q_1 M_1	$N_1 + N_2$ $Q_1 + Q_2$ $M_1 + M_2$	$N_1 + N_2'$ $Q_1 + Q_2'$ $M_1 + M_2'$
Cumulative Stresses		σ_{c1} σ_{t1} τ_1	$\sigma_{c1} + \sigma_{c2}$ $\sigma_{t1} + \sigma_{t2}$ $\tau_1 + \tau_2$	$\sigma_{c1} + \sigma_{c2}'$ $\sigma_{t1} + \sigma_{t2}$ $\tau_1 + \tau_2'$
Design Loads Beared by		Vertical section (cantilever beam element) only	Both the vertical section (cantilever beam element) and horizontal section (arch element)	

4) Design Loads

- Dead Load (W)

$$W = \gamma_c A$$

where, W : dead load (tf/m)

γ_c: unit weight of concrete = 2.35 tf/m^3

A : cross-sectional area (m^2)

- Hydrostatic Pressure (P_1)

$P_1 = \gamma wh$

where, P_1: hydrostatic pressure (tf/m^2)
γw: unit weight of water = 1.0 tf/m^3
h : water depth from reservoir surface adding wave height (m)

- Sediment Pressure (P_2)

$P_2 = Cs\gamma shs$

where, P_2: sediment pressure (tf/m^2)
Cs: coefficient of pressure = 0.5
γs: unit weight of sediment = 1.1 tf/m^3
hs: depth of sediment at an optional point (m)

- Hydrodynamic Pressure (P_3)

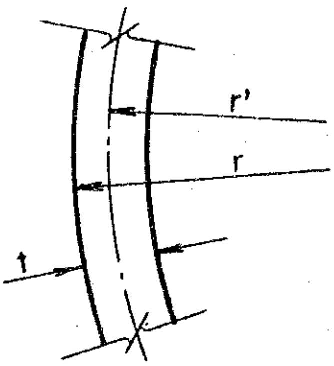
$P_3 = 7/8\,\gamma wk\sqrt{Hh}$ .... Westergaard's formula

where, P_3: hydrodynamic pressure (tf/m^2)
γw: unit weight of water = 1.0 tf/m^3
k : seismic coefficient = 0.12
H : water depth from H.W.L. to foundation rock surface = 630.00 - 487.00 = 143.00 m
h : water depth from H.W.L. to objective point (m)

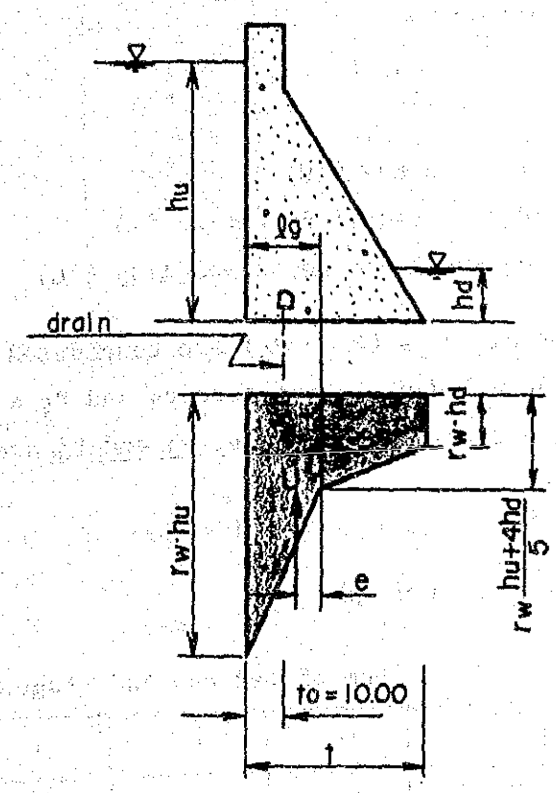
- Seismic Pressure (P_4)

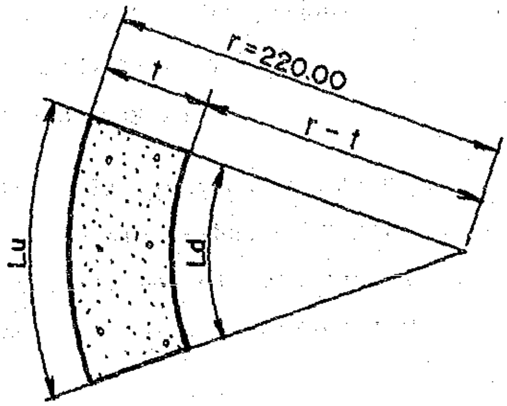
$P_4 = k\gamma ct \cdot r'/r$

where, P_4: seismic pressure (tf/m^2)
K : seismic coefficient = 0.12
γc: unit weight of concrete = 2.35 tf/m^3
t : thickness of dam in radial direction (m)
r : raduis of arch = 220 m
r': raduis of arch in the center of horizontal section = $r - t/2$ (m)



. Uplift (U)





U : uplift (tf/m^2)

hu: upstream water depth (m)

hd: downstream water depth (m)

γw: unit weight of water = 1.0 tf/m^3

lg: distance between upstream face to centroid of base

$$lg = \frac{t}{3}\ \frac{1 + 2\ ld}{1 + ld}\ (m)$$

t : thickness in radial direction (m)

e : eccentricity between working point of uplift and the centroid of base (m)

ld: ld = Ld/Lu = (r - t)/r

• Stress due to decrement of temperature

Decrement of temperature due to changing climate is shown in following formula at each elevation.

$$\Delta T = 60/(t + 2.5) - t'$$

where, ΔT : decrement of temperature (°C)

t : thickness of dam in radial direction (m)

t': preliminary decrement due to sub-cooling (°C)

In these analyses, all horizontal loads (P_1 - P_4) are considered to act in radial direction. Actual dynamic pressure P_3 and P_4 act in parallel to the downstream direction, therefore, P_3 and P_4 are multiplied by direction cosine.

Table A-5-2 Distribution of Uplift

(Sum of 1st and 2nd stages)

Elevation	hu	hd	t	ld	lg	U	e
635.00	-	-	10.00	-	-	-	-
617.00	13.00	-	10.80	0.95	5.35	79.04	1.38
588.00	42.00	-	28.20	0.87	13.77	328.44	7.05
553.00	77.00	-	49.20	0.78	23.59	763.84	12.12
520.00	110.00	-	69.00	0.69	32.39	1,309.00	15.72
487.00	143.00	18.00	88.80	0.60	40.70	3,333.40	7.82

Table A-5-3 Distribution of Seismic Pressure

Elevation	t	r'	P4
635.00	10.00	215.00	2.76
617.00	10.80	214.60	2.97
588.00	28.20	205.90	7.44
553.00	49.20	195.40	12.32
520.00	69.00	185.50	16.41
487.00	88.80	175.60	19.99

Table A-5-4 Decrement of Temperature

Elevation	t	t'	ΔT
635.00	10.00	4	1
617.00	10.80	3	1
588.00	28.20	1	1
553.00	49.20	0	1
520.00	69.00	0	1
487.00	88.80	0	1

Design horizontal loads are shown in Figs. A-5-3 - A-5-5.

5) Stability Conditions

- Safety factor against sliding

$$Fs = \frac{f \cdot N + \tau t}{Q} \geqq 4$$

where, Fs: safety factor against sliding

f : coefficient of inner friction

$f = \tan\phi = \tan 55° = 1.43 \longrightarrow 1.0$

N : axial force (tf/m)

τ : shearing strength = 400 tf/m^2

t : thickness of section (m)

Q : shearing force (tf/m)

Fig. A-5-3 Design Horizontal Loads (3-1)

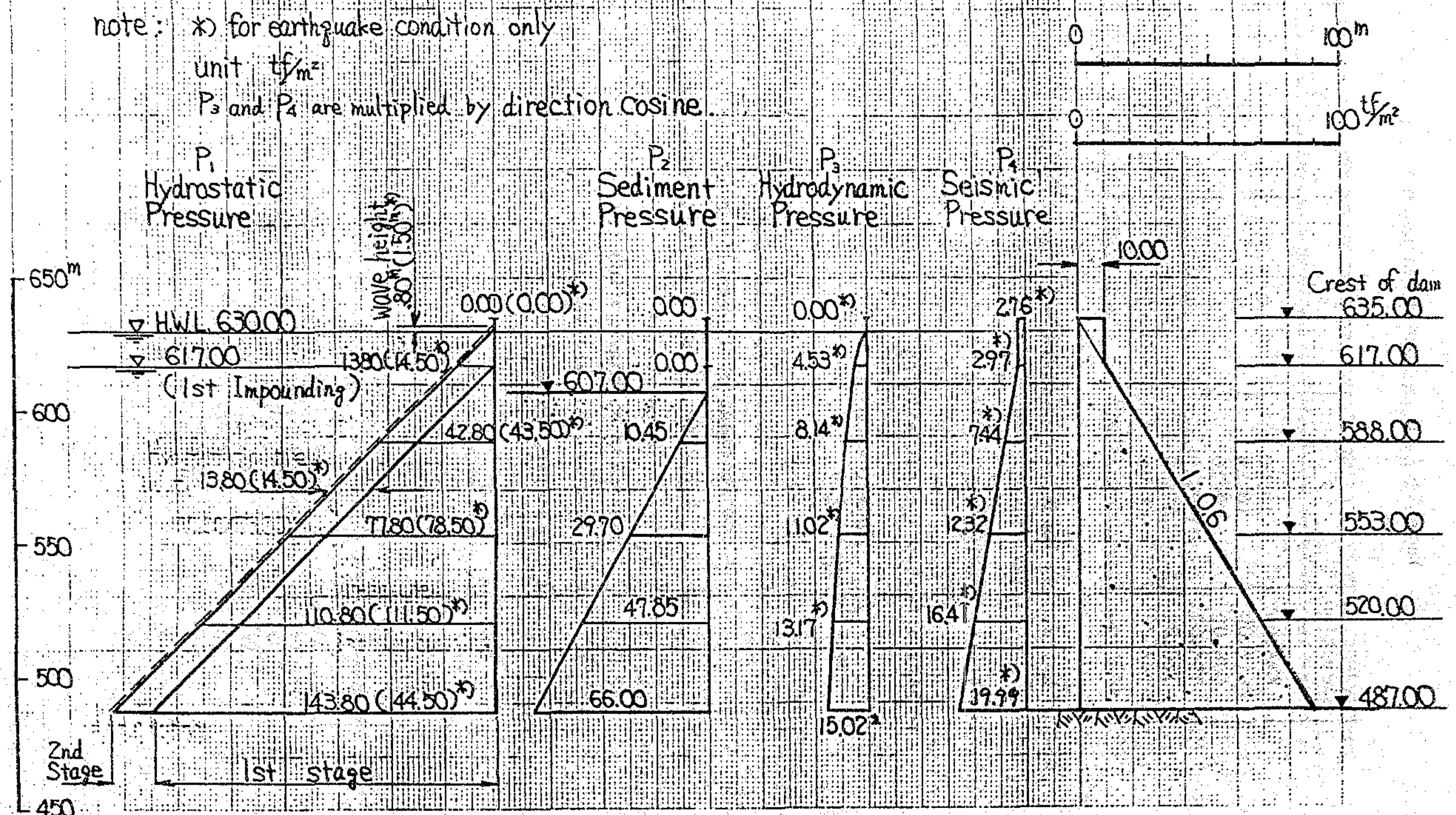


Fig. A-5-4 Design Horizontal Loads (3-2)
(Normal Condition)

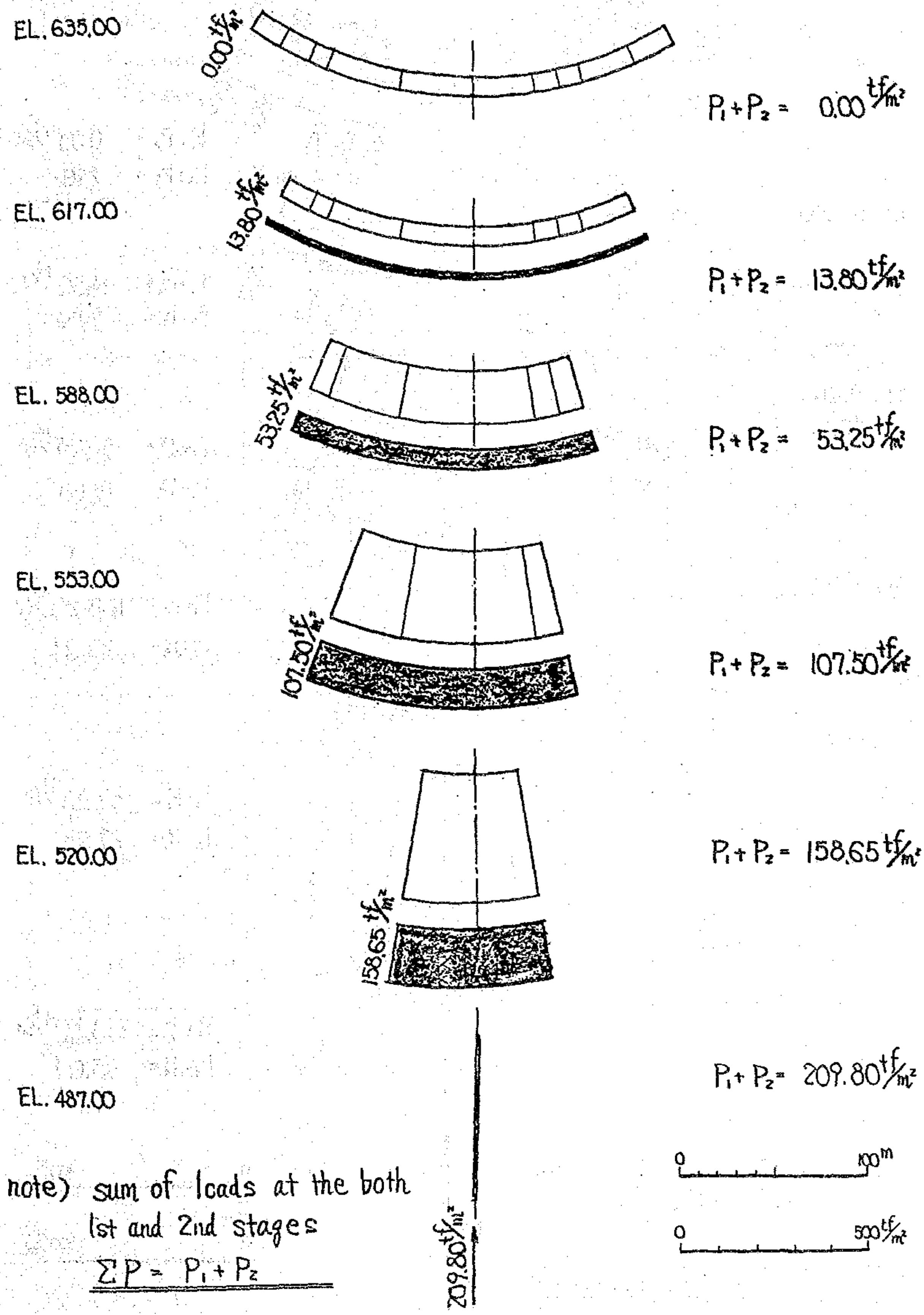
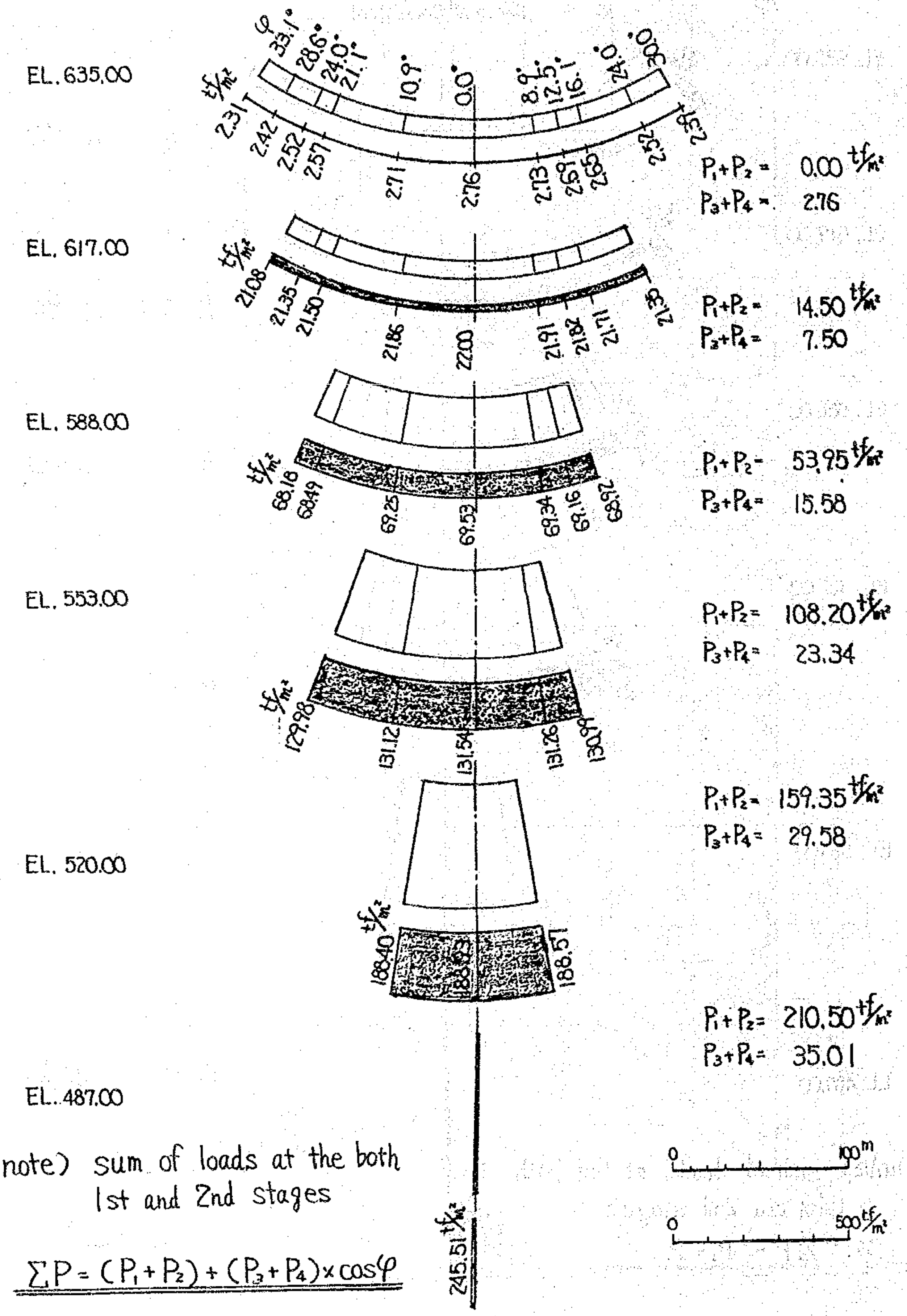


Fig. A-5-5 Design Horizontal Loads (3-3)
(Earthquake Condition)



6) Results

Safety factor against sliding is shown in Table A-5-5. It exceeds 4 in any portion and any case. Distribution and maximum values of stresses are shown in Figs. A-5-6 - A-5-9 and Table A-5-6 respectively.

Table A-5-5 Safety Factor Against Sliding

(Cantilever Beam Elements)

Elevation	t	Left Bank			Right Bank		
		N	Q	Fs	N	Q	Fs
588.00	28.20	1,226 (1,226)	485 (562)	25.8 (22.3)	1,226 (1,226)	654 (818)	19.1 (15.3)
553.00	49.20	3,226 (3,226)	1,525 (1,552)	15.0 (14.8)	3,226 (3,226)	1,458 (1,472)	15.7 (15.6)
520.00	69.00	5,617 (5,617)	4,745 (5,282)	7.0 (6.3)	5,617 (5,617)	3,885 (4,297)	8.6 (7.7)
487.00	88.80	7,057 (7,057)	6,494 (7,185)	6.6 (5.9)	7,057 (7,057)	6,494 (7,185)	6.6 (5.9)

(Horizontal Arch Elements)

Elevation	t	Left Bank			Right Bank		
		N	Q	Fs	N	Q	Fs
617.00	10.80	995 (1,624)	214 (288)	24.8 (20.6)	991 (1,616)	109 (139)	48.7 (42.7)
588.00	28.20	1,609 (2,670)	1,463 (2,205)	8.8 (6.3)	1,620 (2,688)	1,691 (2,574)	7.6 (5.4)
553.00	49.20	1,041 (1,760)	2,062 (3,265)	10.0 (6.6)	1,047 (1,768)	2,223 (3,386)	9.3 (6.3)
520.00	69.00	709 (1,216)	3,594 (5,432)	7.9 (5.3)	708 (1,217)	2,439 (3,671)	11.6 (7.8)

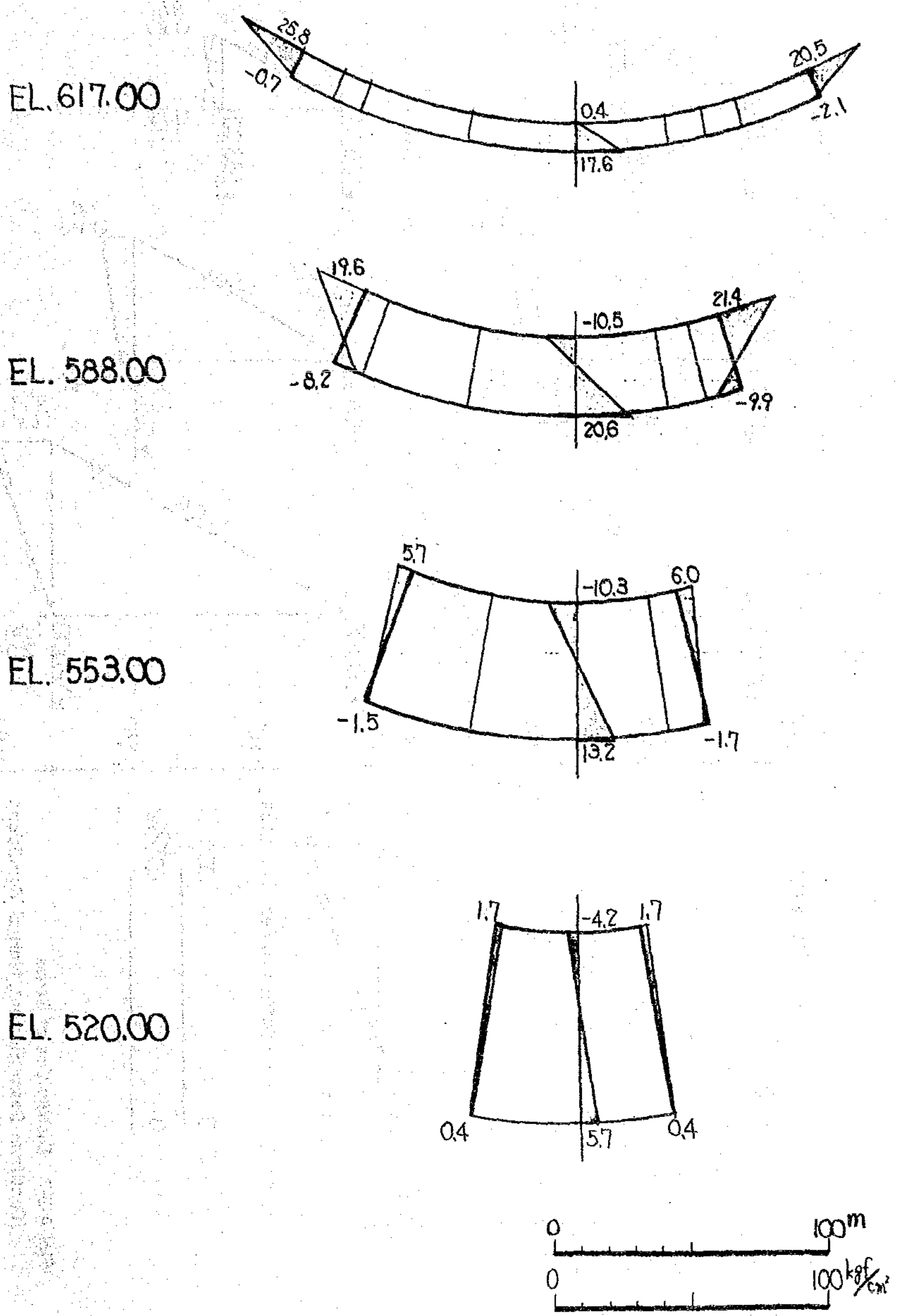
(Note) Unit t (m) N, Q (tf/m)
( ) ... Under earthquake condition

Table A-5-6 Maximum Stresses

	Stress (kgf/cm^2)	Remark
Compressive Stress	32.8 (39.0)	Cantilever beam element, EL. 487.00 (Horizontal arch element, EL. 617.00)
Tensile Stress	-10.5 (-15.3)	Horizontal arch element, EL. 588.00 (ditto)

(Note) ( ) ... Under earthquake condition

Fig. A-5-6 Distribution of Stress
(Horizontal Arch Element, Normal Condition)



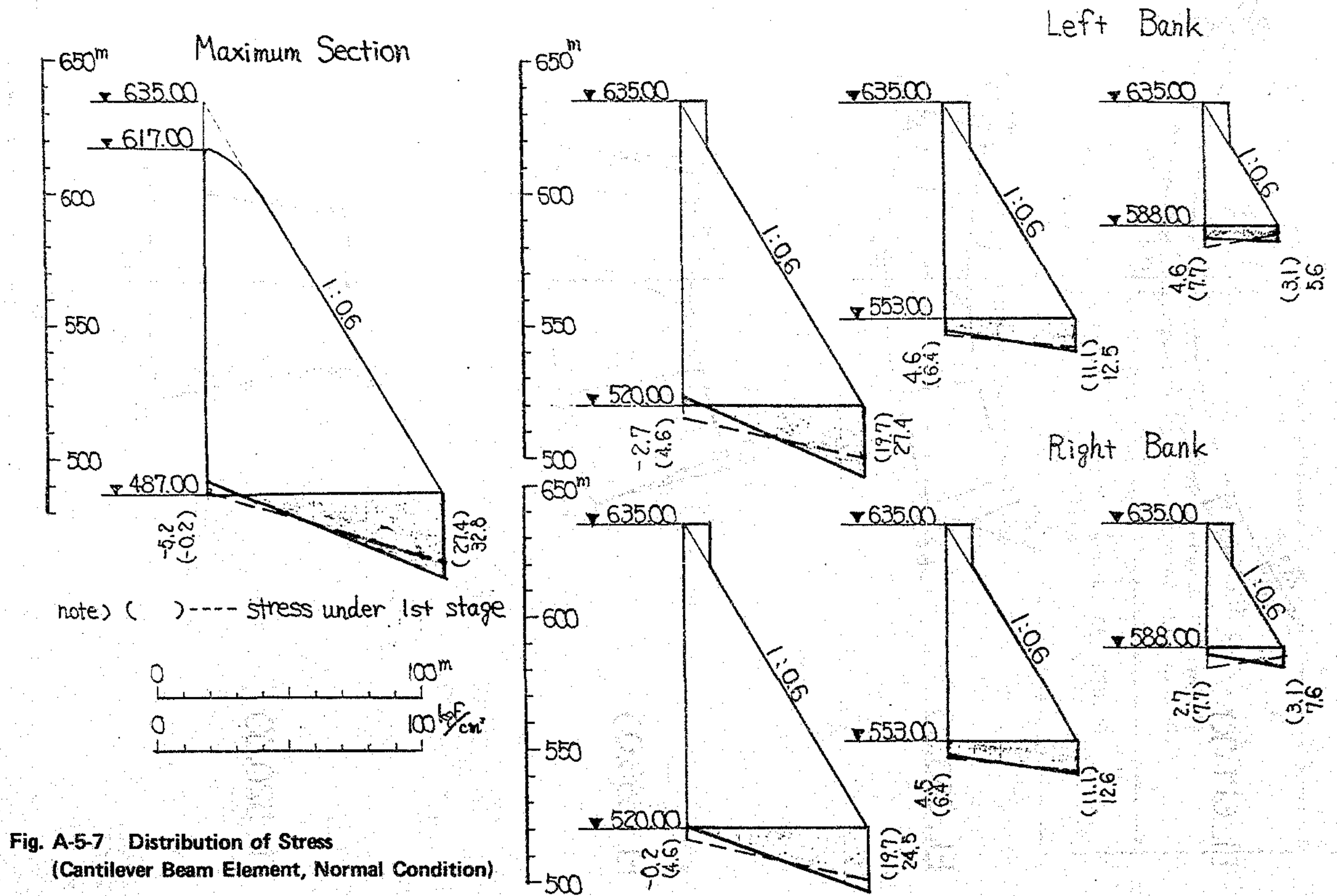
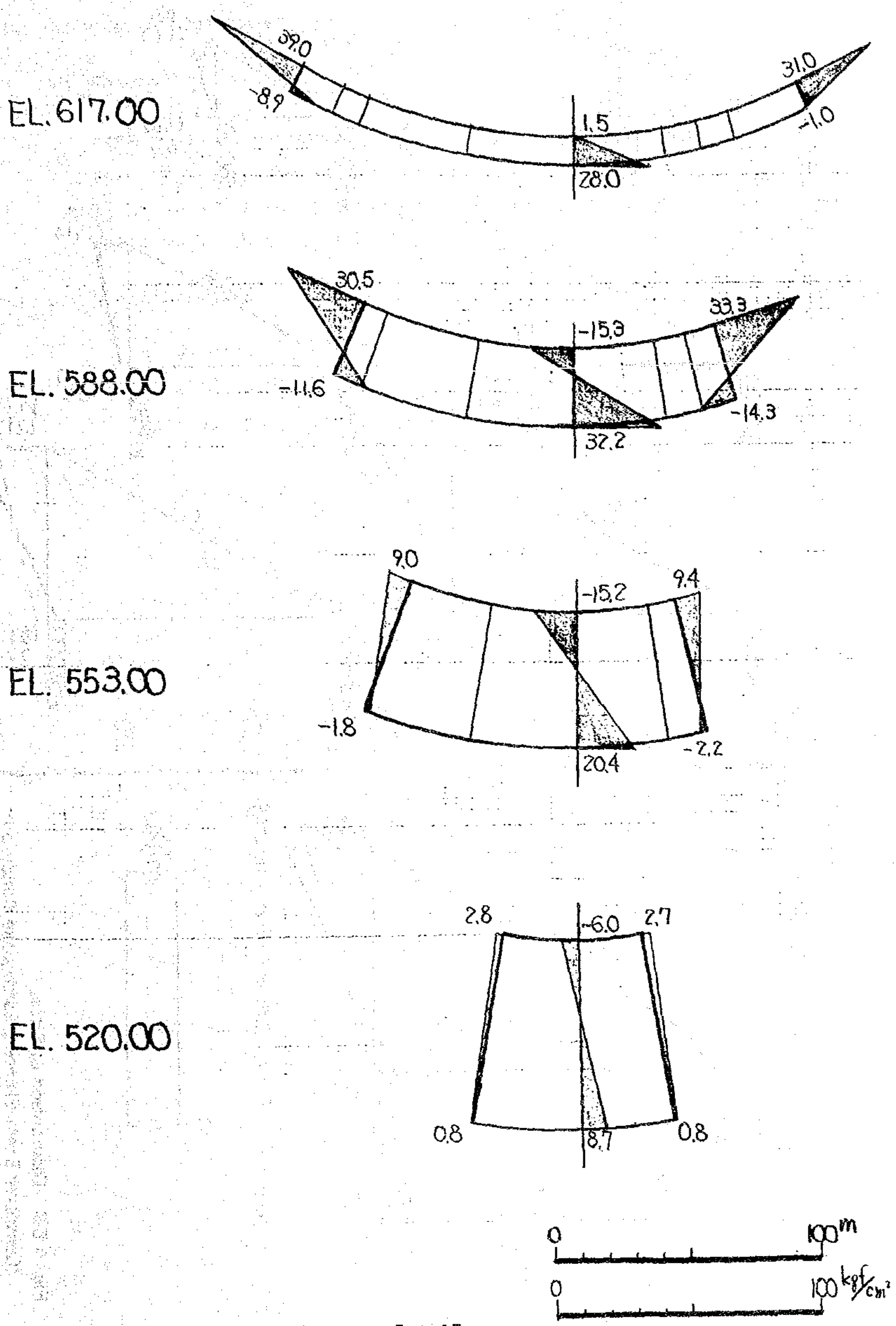


Fig. A-5-7 Distribution of Stress
(Cantilever Beam Element, Normal Condition)

Fig. A-5-8 Distribution of Stress (Horizontal Arch Element, Earthquake Condition)



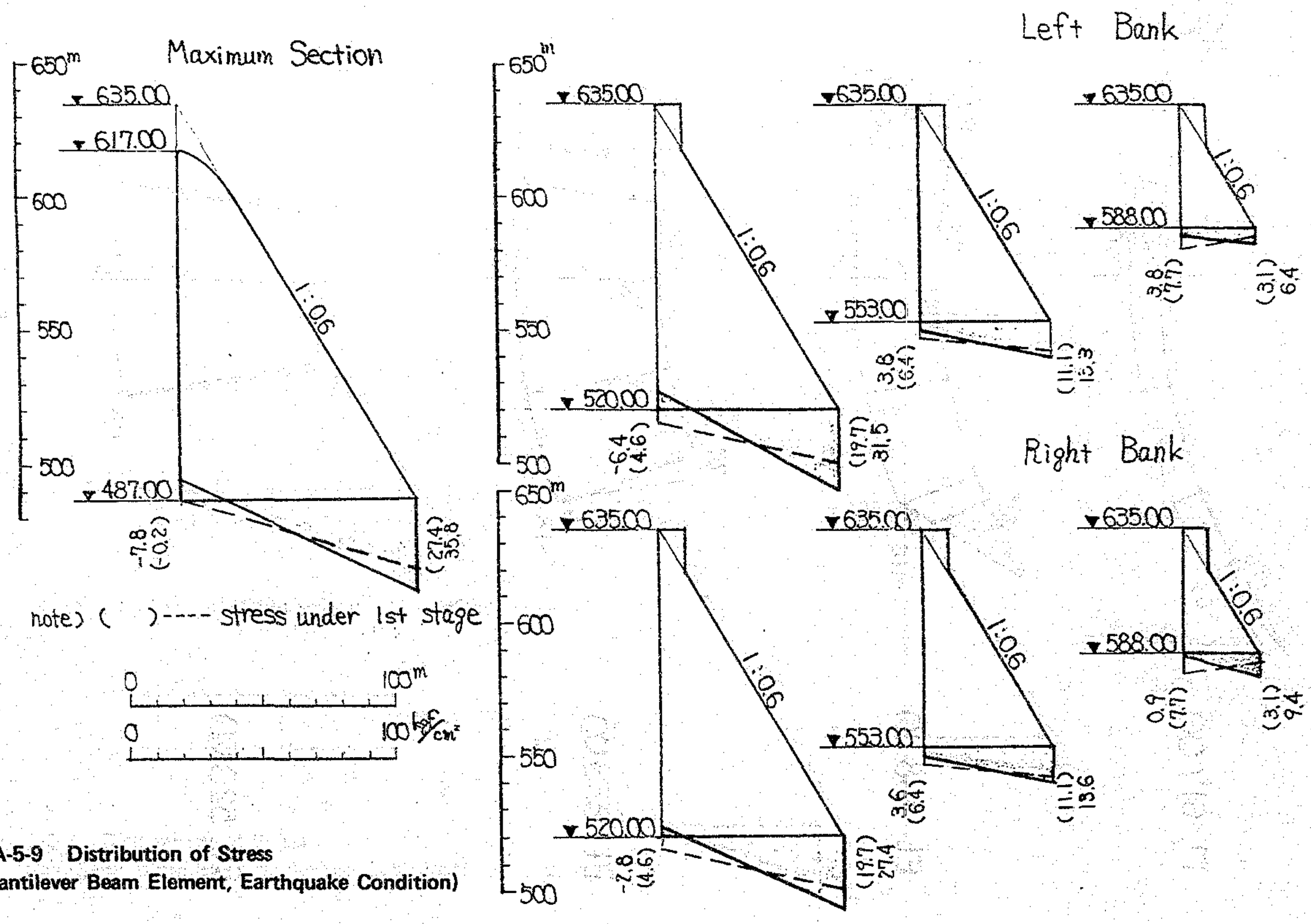


Fig. A-5-9 Distribution of Stress
(Cantilever Beam Element, Earthquake Condition)

5-2 Hydraulic Calculations

I. Capacity of Spillway

1) General

Number and dimensions of spillway gate are determined so as to be able to divert the design flood discharge 3,900 m^3/s at H.W.L. 630 m with all three gates open. Further, max. W.L. is calculated at 3,900 m^3/s with one of the gates out of order.

2) Basic Formulas

Ishii-Fujimoto's Formulas

$$Q = nC'BH^{3/2} \quad (1)$$

$$C' = C\{1 - Md\ (H/Hd)\} \quad (2)$$

$$Md = 0.0756\ (Hd/B)^{0.5} \quad (3)$$

Iwasaki's Formulas

$$C = 1.60\ \frac{1 + 2a\ (H/Hd)}{1 + a(H/Hd)} \quad (4)$$

$$a = \frac{Cd - 1.6}{3.2 - Cd} \quad (5)$$

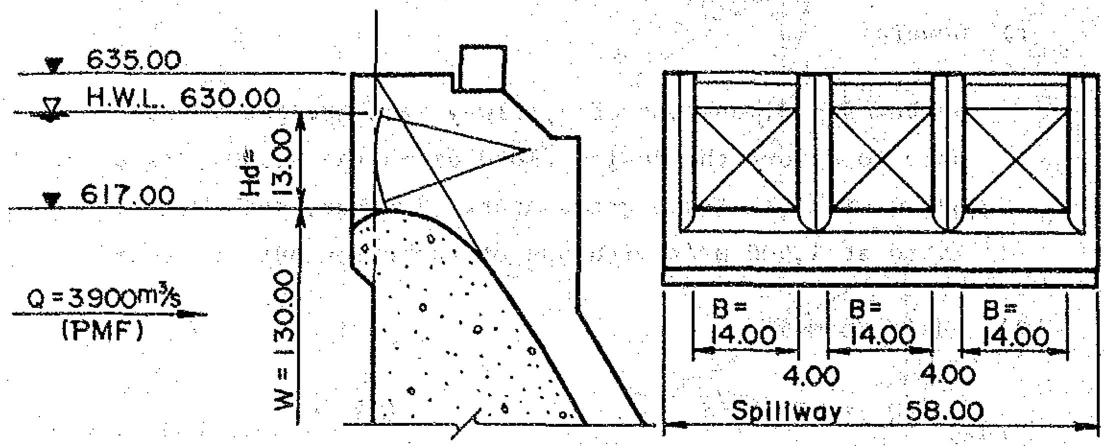
$$Cd = 2.200 - 0.416\ (Hd/W)^{0.990} \quad (6)$$

where,

Q : discharge (m^3/s)
n : number of chute
C': coefficient of discharge with pier effect considered
C : " neglected
Md: reduction ratio of discharge coefficient due to piers
B : width of a chute (m)
H : water depth from reservoir level to weir crest (m)
Hd: water depth from design reservoir level to weir crest (m)
W : height of crest (m)
Cd: value of C when H is equal to Hd
a : constant

3) Design Condition

Fig. A-5-10 Detail of Spillway



Main Features of Spillway Gate

- Number n = 3 (with full gates operated)
  2 (with one of the gates out of order)
- Dimensions B = 14.00
  Hd = 13.00
- Design Discharge Q = 3,900 m^3/s

4) Calculations

$$Cd = 2.200 - 0.416\ (Hd/W)^{0.990}$$
$$= 2.200 - 0.416\ (13.00/130.00)^{0.990}$$
$$= 2.157$$

$$a = \frac{Cd - 1.6}{3.2 - Cd}$$
$$= \frac{2.157 - 1.6}{3.2 - 2.157}$$
$$= 0.534$$

$$C = 1.60 \frac{1 + 2a\,(H/Hd)}{1 + a\,(H/Hd)}$$

$$= 1.60 \times \frac{1 + 2 \times 0.534\,(H/13.00)}{1 + 0.534\,(H/13.00)}$$

$$= \frac{38.95 + 3.20\,H}{24.34 + H}$$

$$Md = 0.0756\,(Hd/B)^{0.5}$$

$$= 0.0756\,(13.00/14.00)^{0.5}$$

$$= 0.0728$$

$$C' = C\left\{1 - Md\,(H/Hd)\right\}$$

$$= C \times \left\{1 - 0.0728 \times (H/13.00)\right\}$$

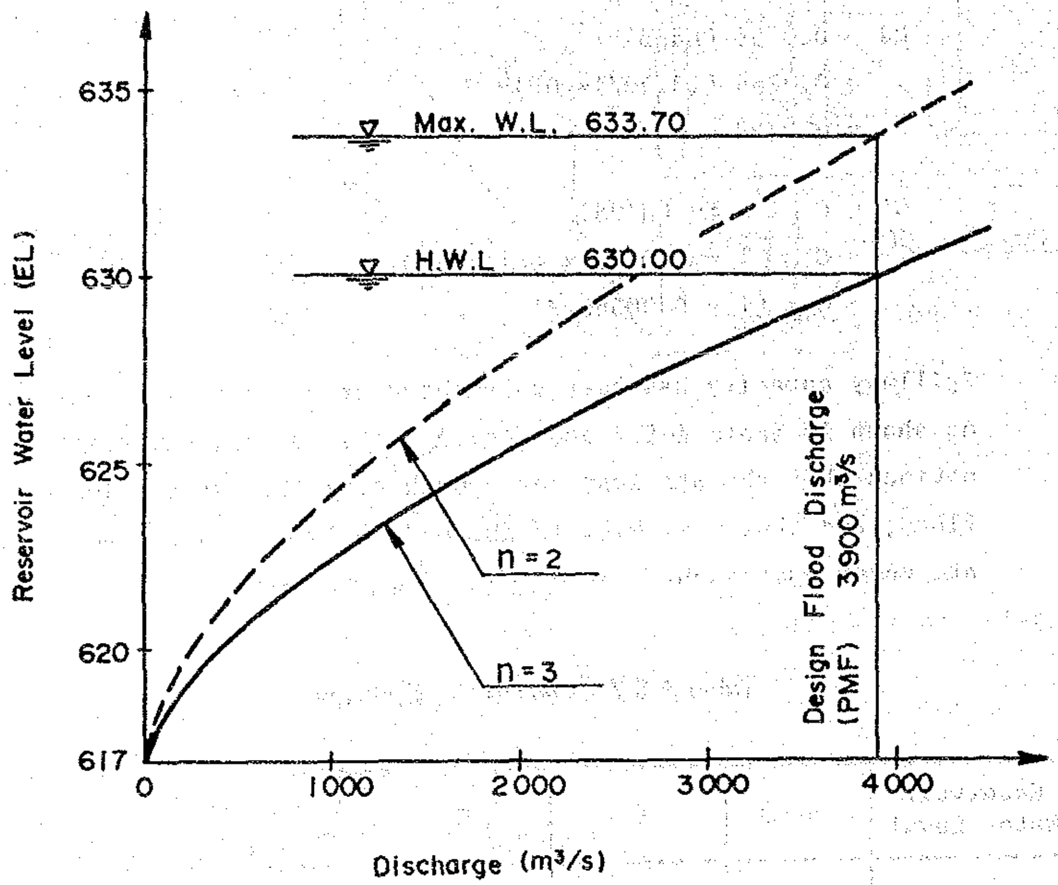
$$= C \times (1 - 0.00560\,H)$$

Spillway capacity has been calculated at various reservoir level as shown in Table A-5-7 and Fig. A-5-11. Consequently, it is obvious that the spillway has enough capacity for the design flood, and that max. W.L. is EL. 633.70 in case only two gates are under operation.

Table A-5-7 Capacity of Spillway

Reservoir Water Level	H(m)	C	C'	$Q = nC'BH^{3/2}$ (m^3/s)	
				n = 3	n = 2
EL. 617.00	0.00	-	-	0	0
620.00	3.00	1.776	1.746	381	254
625.00	8.00	1.996	1.907	1,812	1,208
630.00	13.00	2.157	2.000	3,938	2,625
635.00	18.00	2.280	2.050	6,577	4,385

Fig. A-5-11 Spillway Capacity Curve



II. Freeboard

1) General

The elevation of dam crest is determined enough high not to be lower than reservoir water level adding wave heights and allowances.

2) Basic Formula

$$Ht \geqq \max (H.W.L. + hw + he + ha,\ \max.\ W.L. + hw)$$

where,

Ht: Elevation of dam crest
hw: height of wave due to wind
he: " earthquake
ha: allowance considering delayed gate operation

$hw = 0.00086\ V^{1.1}\ F^{0.45}$ .... SMB Method

V : design wind velocity (average for 10 minutes)
= 30 m/s
F : fetch = 1,000 m

$$he = \frac{1}{2} \times \frac{k\tau}{\pi} \sqrt{g\ Ho}$$

k : seismic coefficient = 0.12
τ : earthquake period = 1 sec
g : accelation of gravity = 9.8 m/s^2
Ho: height from reservoir level to foundation rock
= 143.00 m

3) Calculation

$$hw = 0.00086\ V^{1.1}\ F^{0.45}$$
$$= 0.00086 \times 30^{1.1} \times 1,000^{0.45}$$
$$= 0.81\ \text{m}$$

$$he = \frac{1}{2} \times \frac{k\Gamma}{\pi} \sqrt{g\ Ht}$$
$$= \frac{1}{2} \times \frac{0.12 \times 1}{\pi} \sqrt{9.8 \times 143.00}$$
$$= 0.71\ \text{m}$$

ha = 0.50 m

H.W.L + hw + he + ha = 630.00 + 0.81 + 0.71 + 0.50
= 632.02

Max. W.L. + hw = 633.70 (Refer to A-5-2 I) + 0.81
= 634.51

$Ht \geqq$ max. (H.W.L. + hw + he + ha, Max. W.L. + hw)

= 634.51 ——> E.L. 635.00

Therefore, elevation of dam top was decided 635.00.

III. Capacity of Diversion Tunnel

1) General

The both upstream and downstream water levels are calculated in order to design heights of the cofferdams. The upstream water level is calculated by adding the downstream one to head loss in diversion tunnel when design discharge is diverted.

2) Properties of Diversion Tunnel

Design discharge	Q = 530 m^3/s (10 year return period)
Section	Circular (D = 6.80 m, A = 36.3 m^2)
Length	ℓ = 390 m (adding lengths of inlet and outlet to tunnel length 370 m)
Coefficient of roughness	n = 0.013 (concrete lining)
Elevation of invert	510.00 m (inlet), 505.00 m (outlet)
Downstream water level	EL. 509.00
Bending portions	Number 2
	Radius ρ = 100.00 m
	Angle θ = 36°, 15°
Velocity	v = Q/A = 530/36.3 = 14.6 m/s

3) Calculation of Head Loss in Diversion Tunnel

3)-1 Friction

$$h1 = \frac{124.5\ n^2 \ell}{D^{4/3}} \frac{V^2}{2g}$$

$$= \frac{124.5 \times 0.013^2 \times 390.00}{6.80^{4/3}} \times \frac{14.6^2}{2 \times 9.8} = 6.93\ m$$

3)-2 Bending

$$h2 = \frac{\sum (f_{b1} \cdot f_{b2})}{2g} V^2$$

$$f_{b1} = 0.131 + 0.1632\ (D/\rho)^{7/2}$$

$$= 0.131 + 0.1632 \times (6.80/100.00)^{7/2}$$

$$= 0.131$$

$$f_{b2} = (\theta/90)^{1/2}$$

$$h2 = \frac{0.131 \times (36/90)^{1/2} + 0.131 \times (15/90)^{1/2}}{2 \times 9.8} \times 14.6^2$$

$$= 1.48\ m$$

3)-3 Inlet

$$h3 = \frac{fe}{2g} V^2$$

$$= \frac{0.2}{2 \times 9.8} \times 14.6^2$$

$$= 2.18\ m$$

3)-4 Outlet

$$h4 = \frac{V^2}{2g}$$

$$= \frac{14.6^2}{2 \times 9.8}$$

$$= 10.88$$

3)-5 Total

$h\ell = h1 + h2 + h3 + h4$

$= 6.93 + 1.48 + 2.18 + 10.88$

$= 21.47$

$\fallingdotseq 21.50$ m

4) Height of Cofferdams

$Hd = \max (Hd', Ht)$

$Hu = Hd + h\ell$

Hu : design upstream water level

Hd : design downstream water level

Hd': flood water level = 509.00 m

Ht : top elevation of tunnel at downstream end

= 505.00 + 6.80 = 511.80 m

$h\ell$: head loss = 21.50 m

$Hd = \max (509.00, 511.80) = 511.80$

$Hu = Hd + h\ell$

$= 511.80 + 21.50$

$= 533.30$ m

Therefore, elevation of upstream cofferdam crest is determined EL. 535.00.

IV. Surging

1) General

The hydraulic characteristics of surging are estimated related with those of the headrace tunnel, and needed dimensions of the surge tank are determined as shown below.

a. Diameter of surge tank
b. Surging period
c. Up-surge water level (U.S.W.L.)
d. Length of lower chamber

2) Design Conditions

1. Water Level

H.W.L. 630.00
T.W.L. 321.80

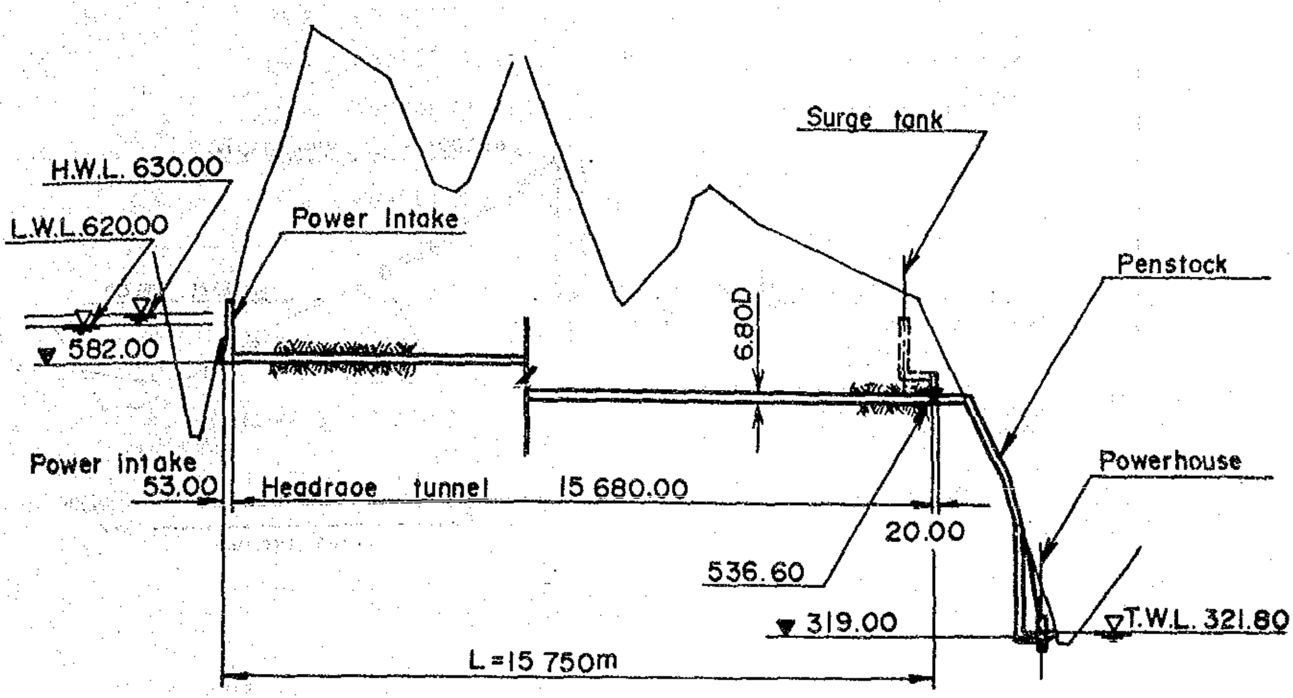
2. Particulars of tunnel

Section	Circular
Diameter	D = 6.80 m
Length	L = 53 (power intake) + 15,680 (headrace tunnel) + 10 (surge tank) ≒ 15,750 m
Elevation	582.00 ~ 536.60 (at bottom of section)

Coefficient of roughness

n = 0.011 (for calculation of up-surging)
0.015 (" down-surging)

Fig. A-5-12 Profile of Headrace Tunnel



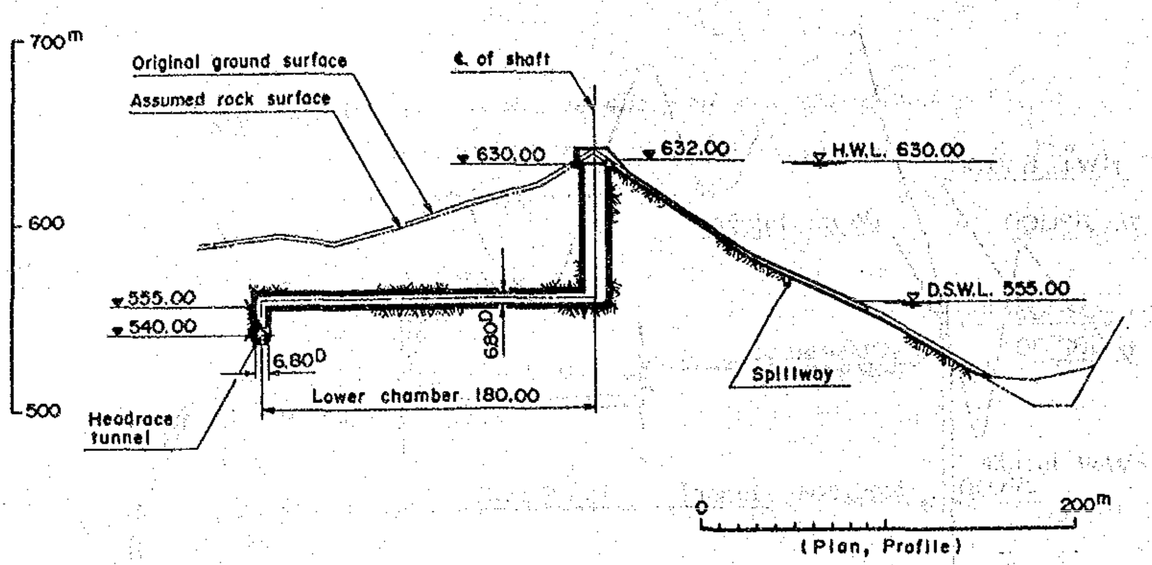
3. Available discharge

$Q = 108\ m^3/s$

4. Features of surge tank

Type	Upper portion ..... overtoppable	
	Lower portion ..... lower chamber	
Lower chamber	Section	circular
	Diameter	D = 6.80 m
	Elevation	EL. 555.00 (at bottom of section)
Overtoppable crest		
	Elevation	EL. 632.00 (H.W.L. + 2.00 m)
Effect of orifice		neglected

Fig. A-5-13 Profile of Surge Tank



3) Calculation Cases

Table A-5-8 Calculation Cases

Case	Reservoir Water Level	Discharge (m^3/s)	Properties of Head Loss *)				
			n	α	β	he	C
1	630.00	108 ⟶ 0	0.011	1.0	0	8.74	0.991
2	595.00	0 ⟶ 108	0.015	1.1	0.1	17.45	1.978

*) (head loss) = (velocity head) + (head loss due to friction) x (1 + contingency)

$$he = \alpha \frac{V^2}{2g} + \frac{124.5\, n^2 L}{D^{4/3}} \frac{V^2}{2g} \times (1 + \beta)$$

$$= C \frac{V^2}{2g}$$

where,

n : coefficient of roughness
α : coefficient of velocity head
β : increase ratio of friction loss
h_e: head loss (m)
C : coefficient of head loss
V : velocity = 2.97 m/s
L : length of tunnel = 15,750 m
D : diameter of tunnel = 6.80 m

4) Diameter of Shaft

Thoma Jaeger's dynamic stability condition

$$Fs \geq \left(1 + 0.482 \frac{Z^*}{Ho}\right) \frac{Lf}{2cgHo}$$

where,

Fs: Cross-sectional area of shaft (m)
L : Length of tunnel = 15,750 m
f : Cross-sectional area of tunnel = 36.32 m^2
C : Coefficient of head loss
g : Acceleration of gravity = 9.8 m/s^2
Ho: Effective head (m)
= Reservoir water level - T.W.L. - head loss (hl)

Z*: Free surge = $Vo \sqrt{Lf/gFs}$ (m)
Vo: velocity in tunnel = 2.97 m/s

Applying inner diameter of 12.00 m, $Fs = \pi/4 \times 12.00^2 = 113.10\ m^2$

Case-1 $Ho = 630.00 - 321.80 - 8.74 = 299.46$ m

$$Z^* = 2.97 \times \sqrt{15,750 \times 36.32/(9.8 \times 113.10)} = 67.47 \text{ m}$$

$$Fs1 \geqq (1 + 0.482 \times \frac{67.47}{299.46}) \times \frac{15,750 \times 36.32}{2 \times 0.991 \times 9.8 \times 299.46}$$

$$= 109.03 \text{ m}^2$$

Case-2 $Ho = 595.00 - 321.80 - 17.45 = 255.75$ m

$Z^* = 67.47$ m

$$Fs2 \geqq (1 + 0.482 \times \frac{67.47}{255.75}) \times \frac{15,750 \times 36.32}{2 \times 1.978 \times 9.8 \times 255.75}$$

$$= 65.03 \text{ m}^2$$

$$Fs = 113.10 \text{ m}^2 > Fs1 \ (109.03 \text{ m}^2),\ Fs2 \ (65.03 \text{ m}^2)$$

Thus, inner diameter 12.00 m for the shaft meets the stability condition and is considered reasonable.

5) Surging Period

To be simplified, free surging period was calculated as following formula.

$$T = 2\pi\sqrt{\frac{LFs}{gf}}$$

where,

- T : surging period (sec)
- L : length of tunnel (m)
- Fs: cross-sectional area of shaft (m^2)
- f : cross-sectional area of tunnel (m^2)
- g : acceleration of gravity (m/s^2)

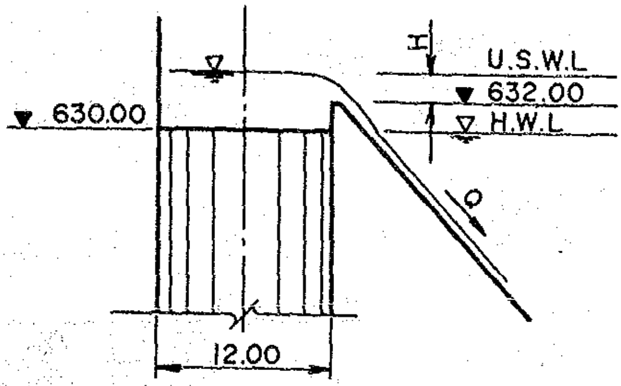
$$T = 2\pi\sqrt{\frac{15,750 \times 113.10}{9.8 \times 36.32}}$$

$$= 444 \text{ sec}$$

$$= 7.4 \text{ min}$$

6) Up-surging Water Level (U.S.W.L.)

As an overtoppable type is selected, up-surging water level corresponds to water surface over the shaft with maximum discharge flown down to the spillway.



$Q = CBH^{3/2}$

where,

C : coefficient of overflow = 1.8

B : width of crest = 12.00 m

H : water depth over crest (m)

Q : discharge (m^3/s)

Here, max. discharge Qmax does not exceed max. available discharge 108 m^3/s, therefore, max. water depth Hmax is calculated as follows:

$$
\begin{aligned}
Hmax &= \left(\frac{Qmax}{C \cdot B}\right)^{2/3} \\
&= \left(\frac{108}{1.8 \times 12.00}\right)^{2/3} \\
&= 2.92 \text{ m}
\end{aligned}
$$

$$
\begin{aligned}
U.S.W.L. &= 632.00 + Hmax \\
&= 632.00 + 2.92 \\
&\fallingdotseq 635.00
\end{aligned}
$$

7) Length of Lower Chamber

Needed length of lower chamber is calculated on design conditions in Case 2 applying Vogt's formulas. The down-surging water level (D.S.W.L.) in the surge tank should not be lower than EL. 555.00, bottom elevation of the lower chamber.

$$Lc = \frac{\varepsilon_s/\varepsilon_2 - 1}{1 - \left(\frac{Xc - \alpha^2}{Xm - \alpha^2}\right)^{\varepsilon_1/\varepsilon_2}} \cdot \frac{Fs}{\overline{Bc}}$$

$$\varepsilon s = \frac{Lf\ Vo^2}{gFsho^2}$$

$$\varepsilon 1 = \frac{2(Xm - \alpha 2)}{\ln(\frac{Xm - 1}{Xm - \alpha^2}) + \frac{1}{\sqrt{Xm}} \ln(\frac{\sqrt{Xm} + 1}{\sqrt{Xm} - 1} \cdot \frac{\sqrt{Xm} - \alpha}{\sqrt{Xm} + \alpha})}$$

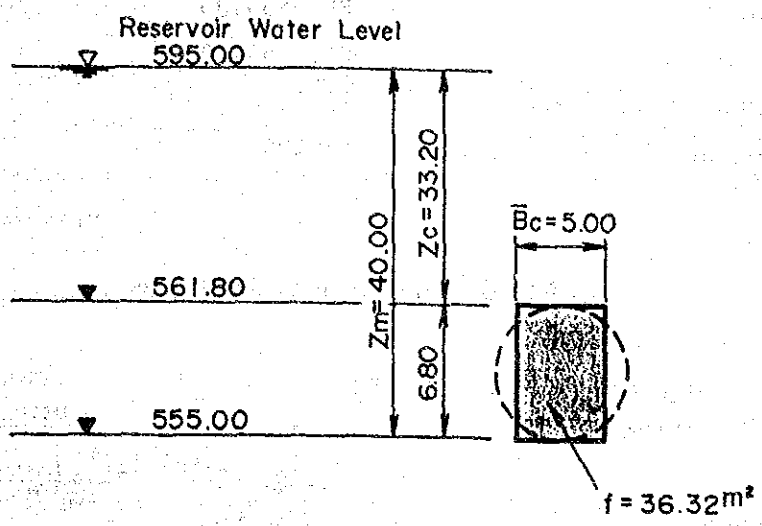
$$\varepsilon_2 = \frac{1}{(1 - \alpha)^2}\left\{(Xm - \alpha^2 - \frac{\phi}{2})^2 - (\frac{\phi}{2})^2\right\}$$

$$\phi = (1 - \alpha)\left\{\frac{\pi}{4}(3 + \alpha) - 2\right\}$$

where,

Lc:	length of lower chamber (m)
L :	length of tunnel = 15,750 m
Fs:	cross-sectional area of shaft = 113.10 m^2
f :	cross-sectional area of tunnel = 36.32 m^2
Vo:	velocity in tunnel = 2.97 m/s
g :	acceleration of gravity = 9.8 m/s^2
$\overline{Bc}$:	equivalent width of lower chamber (m)
α:	ratio of discharge before fluctuation of turbine comparing after that = 0
ho:	head loss = 17.45 m
Xm:	Xm = Zm/ho
Xc:	Xc = Zc/ho
Zm:	distance between reservoir water level and down surging water level (m)

Zc: distance between reservoir water level and top elevation of lower chamber (m)



$$Xm = Zm/ho = 40.00/17.45 = 2.29$$

$$Xc = Zc/ho = 33.20/17.45 = 1.90$$

$$\phi = (1 - 0) \times \left\{\pi/4 \times (3 + 0) - 2\right\} = 0.356$$

$$\varepsilon_s = \frac{15,750 \times 36.32 \times 2.97^2}{9.8 \times 113.10 \times 17.45^2} = 15.0$$

$$\varepsilon_1 = \frac{2 \times (2.29 - 0^2)}{\ln\left(\frac{2.29 - 1}{2.29 - 0^2}\right) + \frac{1}{\sqrt{2.29}} \ln\left(\frac{\sqrt{2.29} + 1}{\sqrt{2.29} - 1} \cdot \frac{\sqrt{2.29} - 0}{\sqrt{2.29} + 0}\right)}$$

$$= \frac{4.58}{-0.574 + 1.050}$$

$$= 9.62$$

$$\varepsilon_2 = \frac{1}{(1 - 0)^2} \times \left\{(2.29 - 0^2 - \frac{0.356}{2})^2 - (\frac{0.356}{2})^2\right\}$$

$$= 4.43$$

$$Lc = \frac{15.0/4.43 - 1}{1 - \left(\frac{1.90 - 0^2}{2.29 - 0^2}\right)^{9.62/4.43}} \times \frac{113.10}{5.00}$$

$$= \frac{3.39 - 1}{1 - 0.667} \times 22.6$$

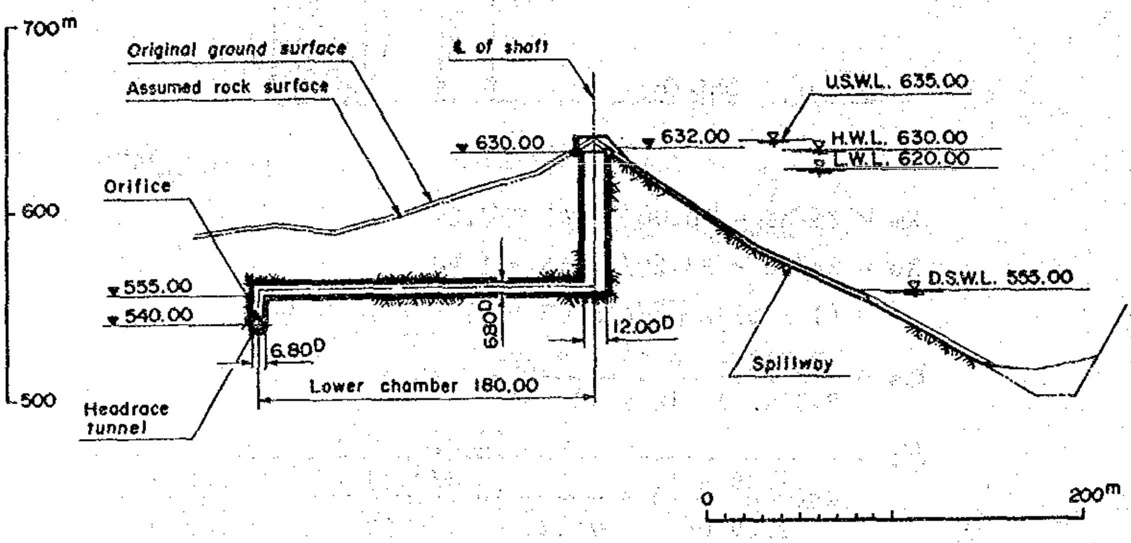
$$= 162 \text{ m}$$

On account of contingency of 10%, the length of chamber is determined 180 m.

8) Results

U.S.W.L.	EL. 635.00
D.S.W.L.	EL. 555.00
Diameter of shaft	12.00
Length of lower chamber	180.00

Fig. A-5-14 Dimensions of Surge Tank



V. Backwater for Tailwater Level

1) General

Tailwater level (T.W.L.) at the Goktas powerhouse is obtained as a result of backwater calculations. These calculations are based on cross section data around the powerhouse (K1 - K6) measured in Sep. 1989.

2) Design Conditions

Discharge

Available discharge at P/S	108 m^3/s
Residual discharge between the dam and P/S	14 m^3/s
Total Discharge	122 m^3/s

Cross section data

As shown in Figs. A-5-15 and A-5-16

Initial condition for backwater calculation

Water depth in K-6, the most downstream section, is assumed that of uniform flow, applying gradient of river flow 1/250 measured in Sep. 1989.

Properties concerning head loss

Coefficient of roughness	$n = 0.04$
Supplementary coefficient for velocity head	$\alpha = 1.1$

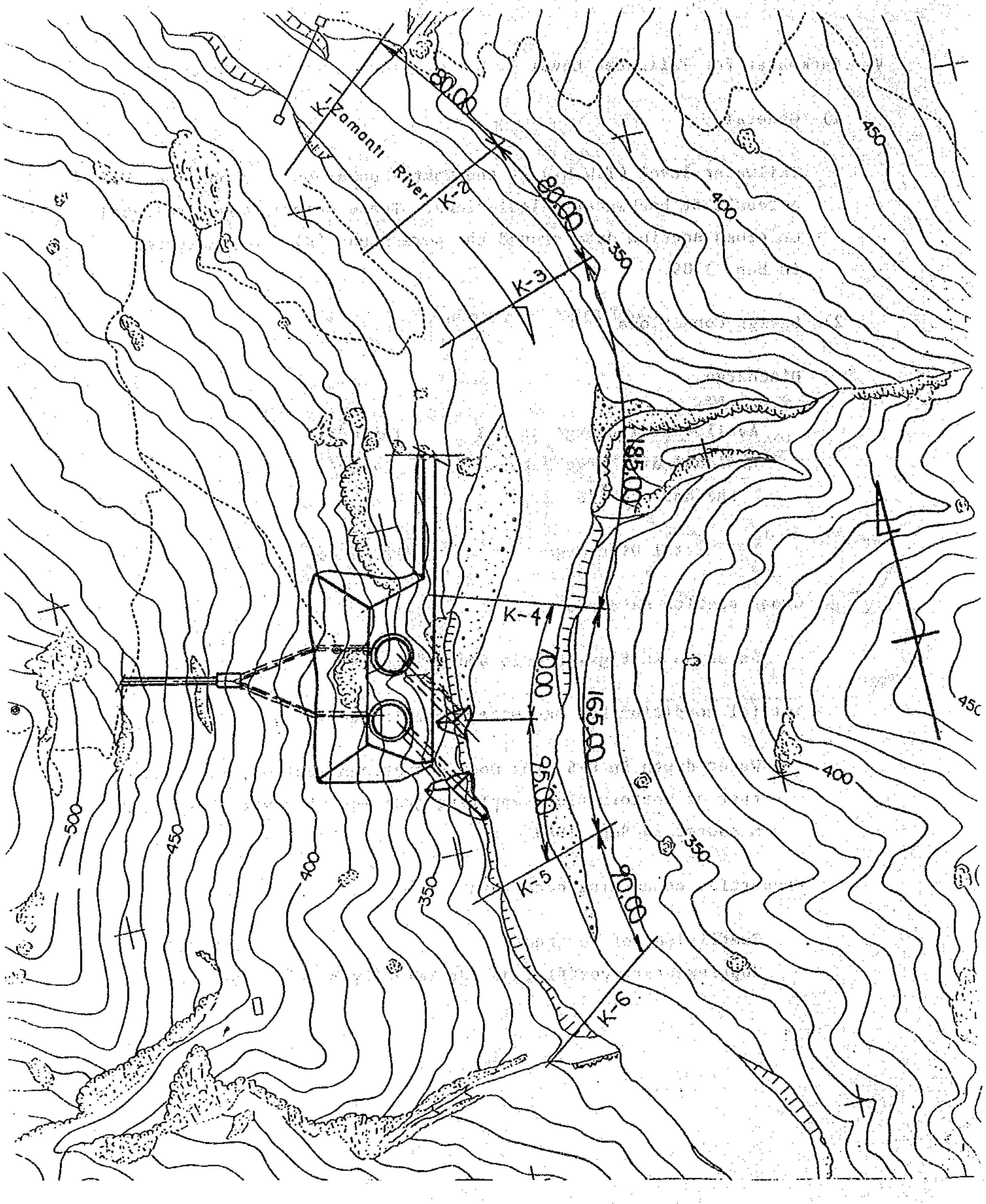
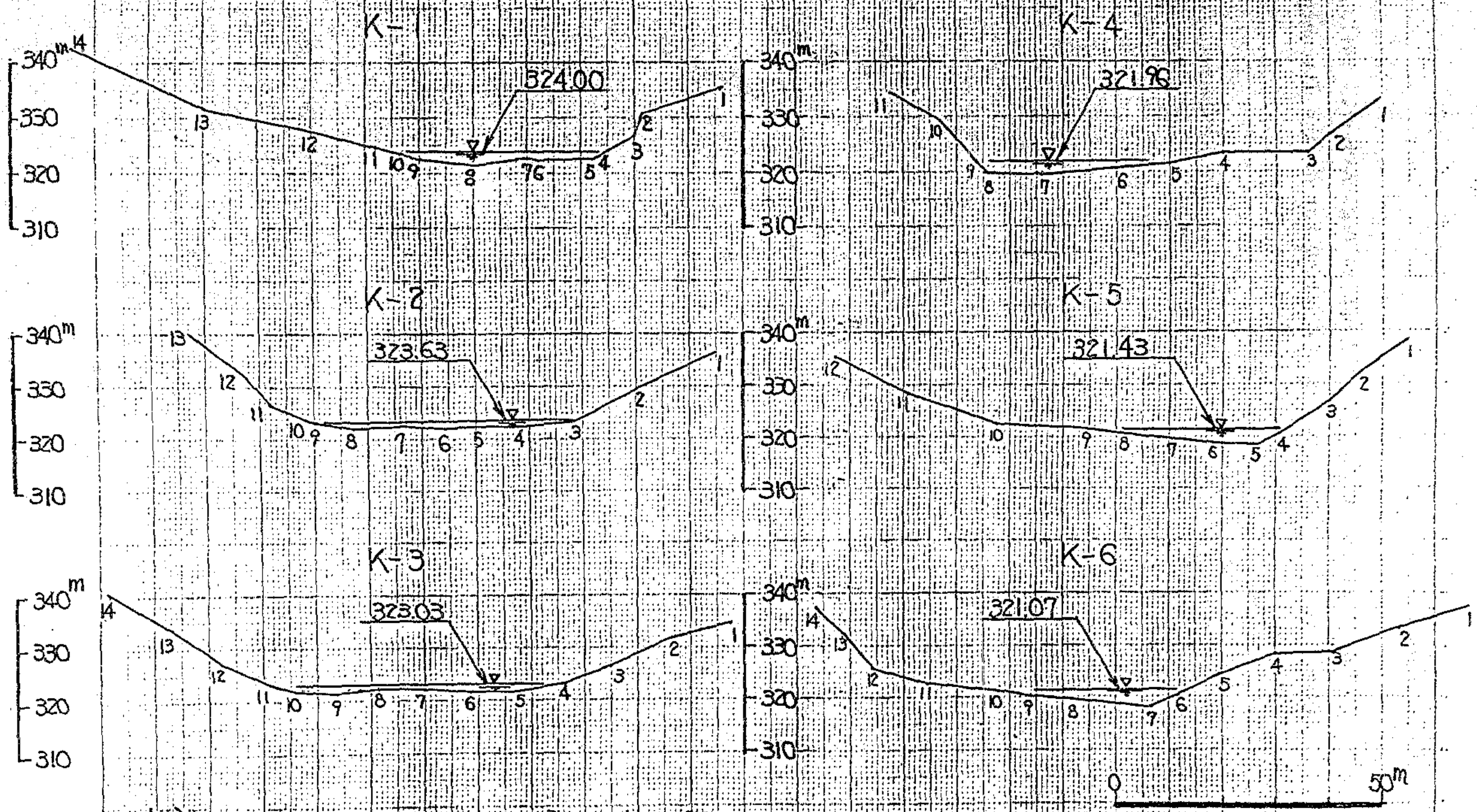


Fig. A-5-15 Powerhouse Plan

Fig. A-5-16 Cross Sections



note)
Water levels shown above are for discharge of 122 m³/s.

3) Results

Rating curve at Goktas P/S is shown in Fig. A-5-17. Tailwater level (T.W.L.) is determined EL. 321.80 for design discharge of 122 m^3/s.

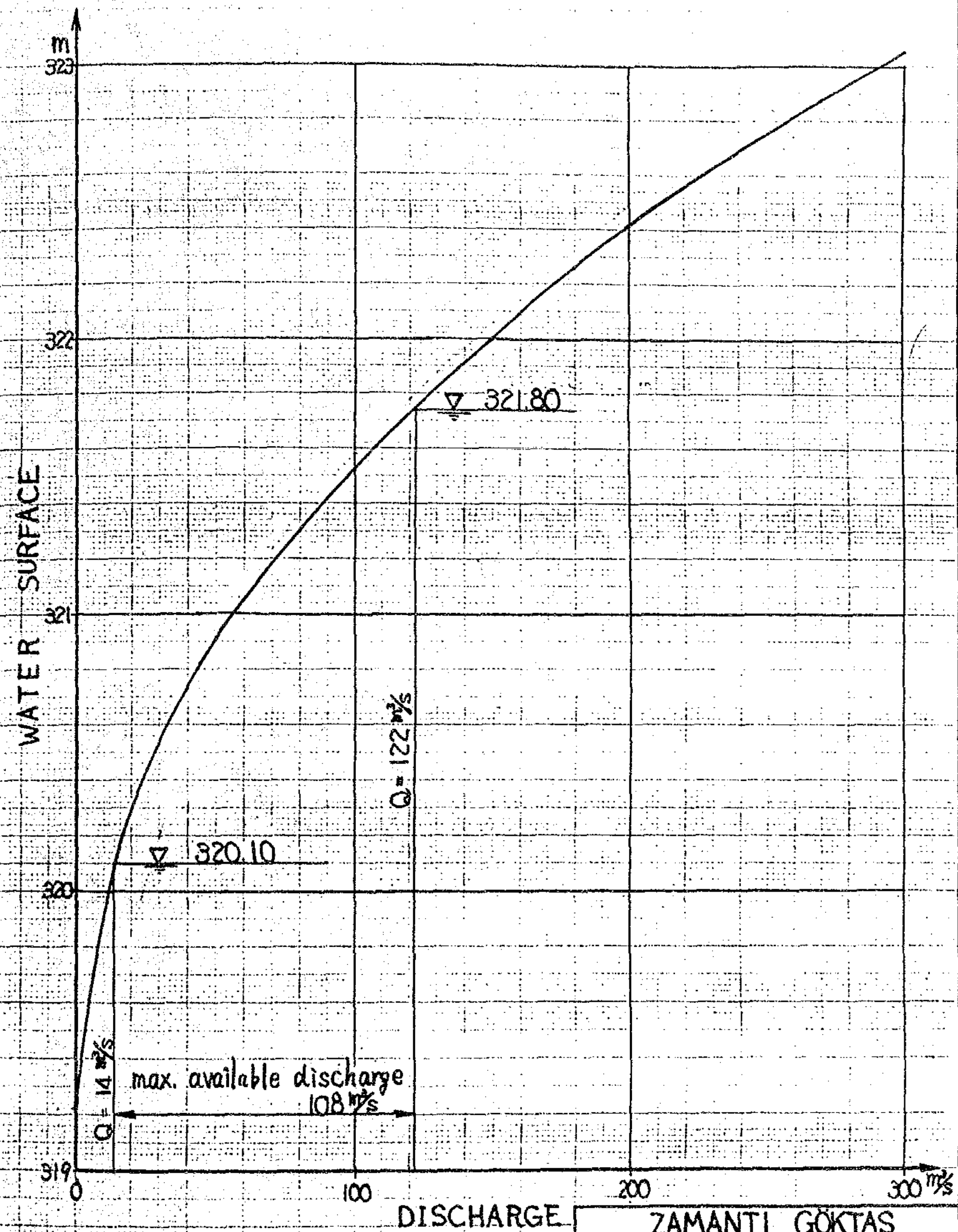


Fig. A-5-17

ZAMANTI GÖKTAŞ

Tailrace Rating Curve

ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO JAPAN

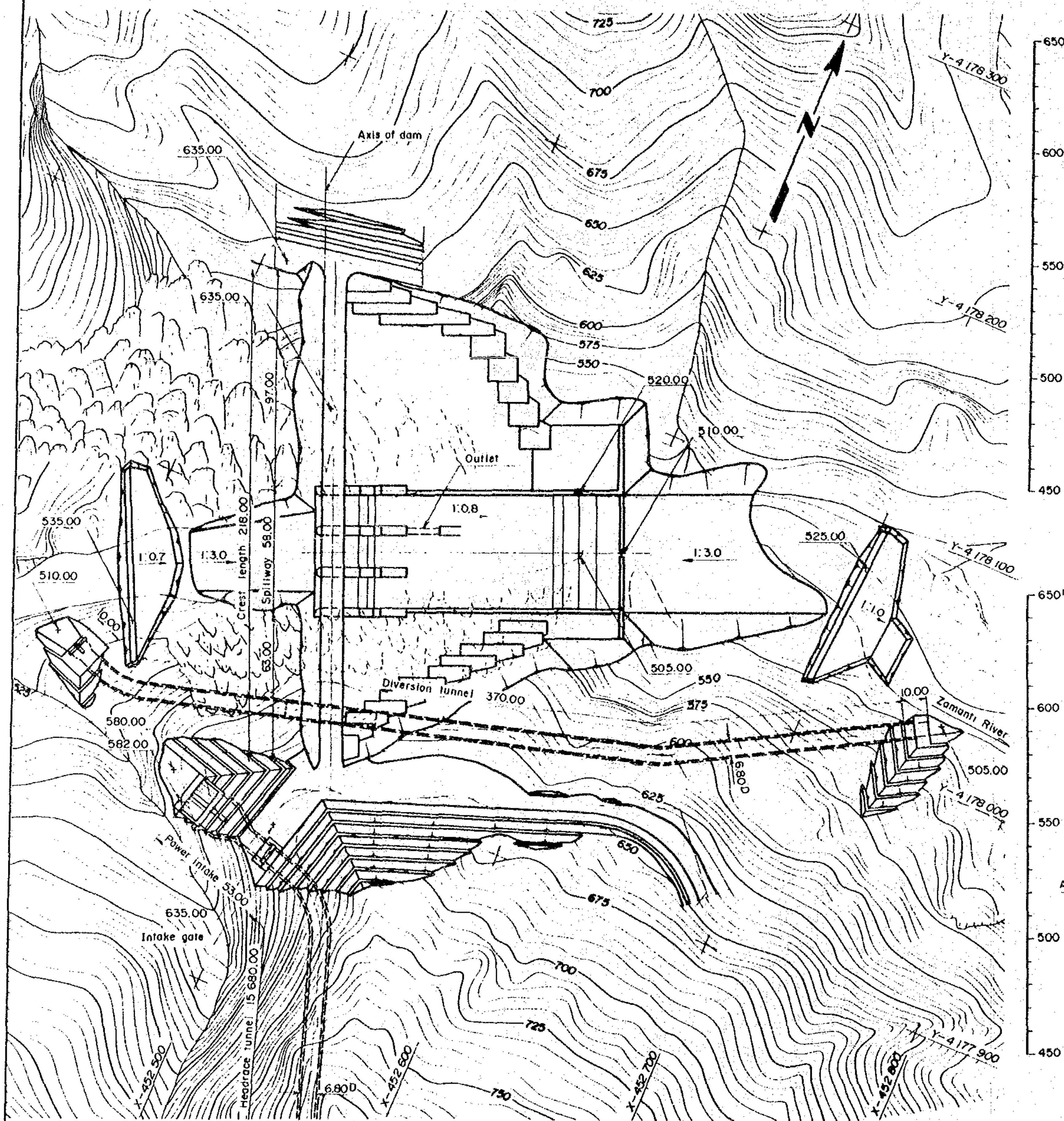
LOCATION	DATE	DESCRIPTION	BY
REVISION			

D.R.: SUBMITTED:
T.R.: RECOMMENDED:
C.K.: APPROVED:

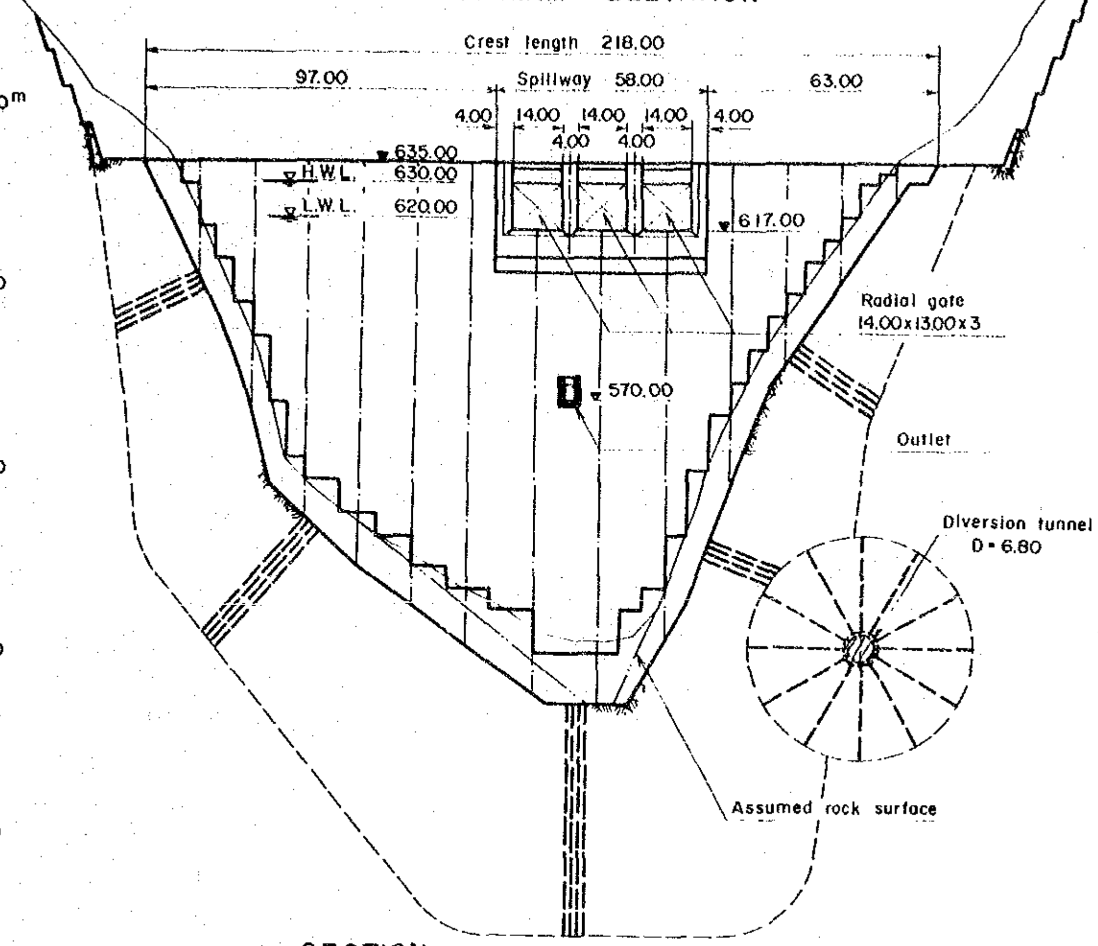
SHEET NO. OF

5-3 Drawing of Comparative Dam (Gravity Type)

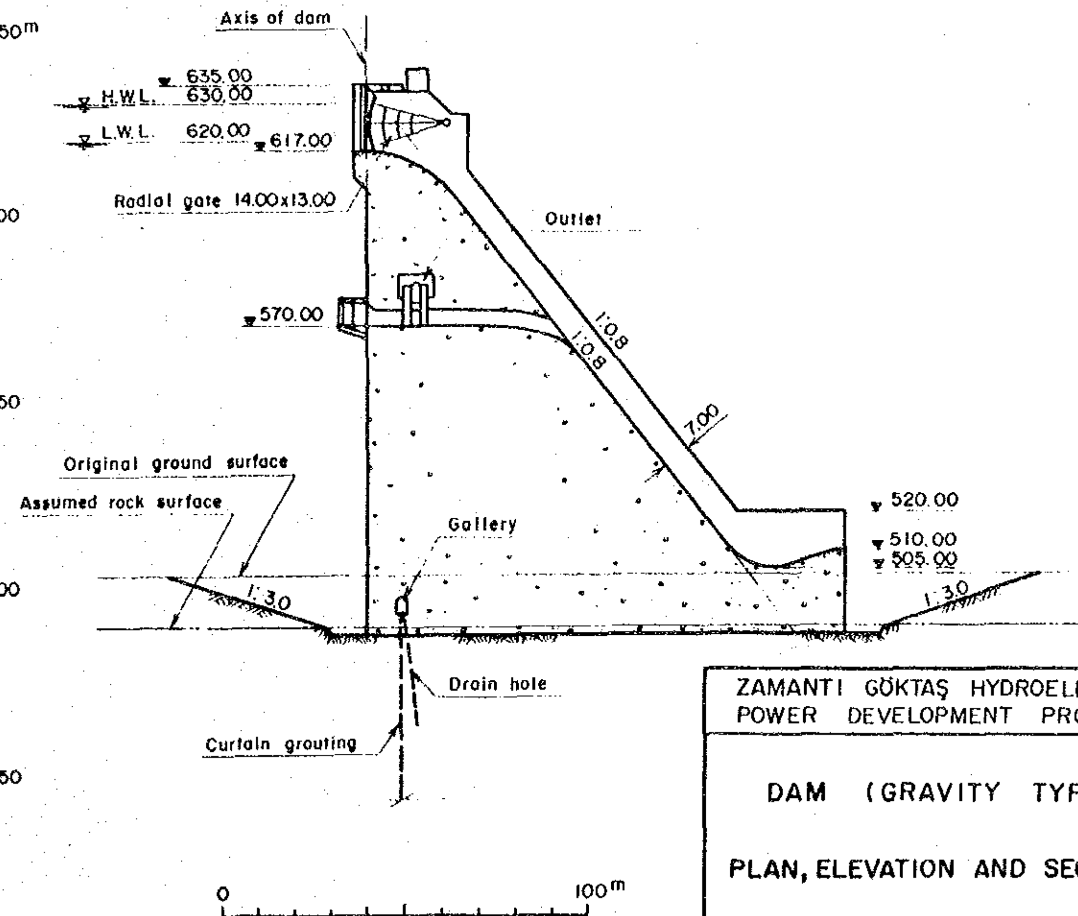
PLAN



UPSTREAM ELEVATION



SECTION



ZAMANTI GÖKTAŞ HYDROELECTRIC POWER DEVELOPMENT PROJECT	
DAM (GRAVITY TYPE)	
PLAN, ELEVATION AND SECTION	
DWG. A-5-1	

A–6 ENVIRONMENT

A-6 ENVIRONMENT

List of Tables

Table A-6-1 Water Analysis Data (1)

GS : 1802

Item	Date / Unit	1988						
		6/21	7/6	7/22	8/4	8/18	9/15	/
Discharge	m^3/s	24	30.7	20	20	18	18	
Temperature of Water	℃	16	21	23	21	17	18	
pH	—	7.78	7.62	7.98	7.71	7.41	7.34	
Electrical Conductivity	mhos/cm	371	368	355	387	443	429	
Total Soluted Solids	mg/ℓ	237	236	227	252	284	274	
Suspended Solids	mg/ℓ	563	364	173	248	516	426	
Total Solids	mg/ℓ	800	600	400	500	800	700	
Meta Oranj Alkalinity	mg/ℓ	130	115	100.0	125	130	140	
Phenolphtalein Alkalinity	mg/ℓ	0	0	0	0	0	0	
Chloride	mg/ℓ	17.7	21.9	22.6	22.7	27.6	25.5	
Ammonia Nitrogen	mg/ℓ	6.0	0.55	0.11	1.36	0.55	0.92	
Nitride Nitrogen	mg/ℓ	0.013	0.004	0	0.013	0	0.006	
Nitrate Nitrogen	mg/ℓ	1.5	1.30	0	1.5	1.50	1.6	
Soluted Oxygen	mg/ℓ	—	—	—	—	—	—	
Permanganate Value	mg/ℓ	6.8	4.9	0.8	0.6	1.7	2.3	
Biochemical Oxygen Value	mg/ℓ	—	—	—	—	—	—	
Total Hardness	mg/ℓ	17.5	16.5	15.5	—	—	—	
Ortho-Phosphate	mg/ℓ	2.1	0.9	0	0.4	0.4	0.9	
Sulphate	mg/ℓ	88.2	56.5	49	58.6	57.2	53.3	
Free Carbondioxide	mg/ℓ	—	—	—	—	—	—	
Iron	mg/ℓ	0.62	—	—	—	—	—	
Mangan	mg/ℓ	0.20	—	—	—	—	—	
Natrium	mg/ℓ	10.6	16.1	18.9	19.3	16.6	20.24	
Kalium	mg/ℓ	2.3	1.6	1.6	1.6	1.9	1.9	
Calcium	mg/ℓ	58.1	42.1	40.0	48.1	56.1	54.1	
Magnesium	mg/ℓ	7.3	14.6	13.3	14.6	12.2	12.2	
Bacterial Analysis	MPN/100mℓ	24	—					
Organic Nitrate	mg/ℓ	—						
Fluorine	mg/ℓ	—						
Boron	mg/ℓ	—						
Phenol	mg/ℓ							
Oil	mg/ℓ							

Table A-6-2 Water Analysis Data (2)

GS : Dam Site

Item	Unit \ Date	1988						
		6/13	6/23	7/11	8/4	9/16	/	/
Discharge	m³/s	—	68.0	55.0	38.0	—		
Temperature of Water	℃	17	18	17	17	15		
pH	—	8.1	8.4	8.2	8.1	8.4		
Electrical Conductivity	mhos/cm	362	360	332	339	322		
Total Soluted Solids	mg/ℓ	203	225	221	204	234		
Suspended Solids	mg/ℓ	847	789	89	69	55		
Total Solids	mg/ℓ	1050	1014	310	273	289		
Meta Oranj Alkalinity	mg/ℓ	120	135	120	110	80		
Phenolphtalein Alkalinity	mg/ℓ	20	10	20	20	40		
Chloride	mg/ℓ	17.73	17.73	17.73	17.73	21.27		
Ammonia Nitrogen	mg/ℓ	0.16	0.15	0.33	0.22	0.23		
Nitride Nitrogen	mg/ℓ	0.005	0.004	0	0	0		
Nitrate Nitrogen	mg/ℓ	0.76	0.56	0.68	0.57	0.72		
Soluted Oxygen	mg/ℓ	9.4	9.9	8.7	9.0	9.1		
Permanganate Value	mg/ℓ	3.6	3.52	1.36	1.12	1.20		
Biochemical Oxygen Value	mg/ℓ	2.8	1.4	1.1	0.6	1.20		
Total Hardness	mg/ℓ	170	175	170	145	165		
Ortho-Phosphate	mg/ℓ	0	0	0	0.05	0.17		
Sulphate	mg/ℓ	22.56	23.52	24.46	13.92	33.60		
Free Carbondioxide	mg/ℓ	—	—	—	—	—		
Iron	mg/ℓ	—	—	—	—	—		
Mangan	mg/ℓ	—	—	—	—	—		
Natrium	mg/ℓ	8.51	9.2	10.12	11.5	11.04		
Kalium	mg/ℓ	1.56	1.95	1.56	1.56	1.56		
Calcium	mg/ℓ	44.0	32.0	42.0	30.0	30.0		
Magnesium	mg/ℓ	14.59	23.10	15.81	17.02	21.89		
Bacterial Analysis	MPN/100mℓ	—	—	—	—	—		
Organic Nitrate	mg/ℓ	—	—	—	—	—		
Fluorine	mg/ℓ	—	—	—	—	—		
Boron	mg/ℓ	—	—	—	—	—		
Phenol	mg/ℓ	—	—	—	—	—		
Oil	mg/ℓ	—	—	—	—	—		

Table A-6-3 Water Analysis Data (3)

GS : 1806

Item	Date / Unit	1988						
		3/29	4/27	5/24	6/24	7/13	8/8	9/16
Discharge	m^3/s	552.0	266.0	139.0	109.5	60.0	55.5	—
Temperature of Water	℃	11	14	17	16	18	18	16
pH	—	7.9	8.3	8.1	8.2	8.0	8.0	8.2
Electrical Conductivity	mhos/cm	290	340	324	395	381	378	399
Total Soluted Solids	mg/ℓ	184	203	205	237	243	261	286
Suspended Solids	mg/ℓ	3258	685	154	513	92	27	25
Total Solids	mg/ℓ	3442	888	359	750	335	288	311
Meta Oranj Alkalinity	mg/ℓ	125	130	125	115	120	100	110
Phenolphtalein Alkalinity	mg/ℓ	0	30	10	50	30	40	40
Chloride	mg/ℓ	7.09	10.64	17.73	17.73	24.82	24.82	28.36
Ammonia Nitrogen	mg/ℓ	0.26	0.26	0.36	0.21	0.23	0.35	0.20
Nitride Nitrogen	mg/ℓ	0	0	0	0	0.001	0	0
Nitrate Nitrogen	mg/ℓ	0.83	1.01	0.96	0.70	0.71	0.63	0.73
Soluted Oxygen	mg/ℓ	11.0	9.6	9.4	9.8	7.5	8.3	9.4
Permanganate Value	mg/ℓ	5.44	1.20	1.36	2.32	1.28	0.64	0.80
Biochemical Oxygen Value	mg/ℓ	2.7	0.8	0.9	0.6	0.6	0.6	0.8
Total Hardness	mg/ℓ	145	185	165	185	190	175	190
Ortho-Phosphate	mg/ℓ	0	0	0	0	0	0.09	0.06
Sulphate	mg/ℓ	17.76	18.72	21.12	22.08	24.96	23.52	35.04
Free Carbondioxide	mg/ℓ	—	—	—	—	—	—	—
Iron	mg/ℓ	0.15	—	—	—	—	—	—
Mangan	mg/ℓ	0	—	—	—	—	—	—
Natrium	mg/ℓ	4.14	5.98	6.9	9.89	12.42	12.65	23.40
Kalium	mg/ℓ	1.17	1.56	1.17	1.56	1.56	1.56	1.56
Calcium	mg/ℓ	40.0	32.0	36.0	52.0	50.0	40.0	26.0
Magnesium	mg/ℓ	10.91	25.54	18.24	13.38	15.81	18.24	30.4
Bacterial Analysis	MPN/100mℓ	2400	—					—
Organic Nitrate	mg/ℓ	0.22	—					—
Fluorine	mg/ℓ	0	—					—
Boron	mg/ℓ	—	—					—
Phenol	mg/ℓ	—	—					—
Oil	mg/ℓ	—	—					—

Table A-6-4 Sources of Noise and Maximum Tolerable Noise Levels

Noise sources	Noise level Leq db A
Trucks (at 7.5m)	85
Passenger vehicles (at 7.5m)	85
Motorcycle (at 7.5m)	80
Locomotive (at 30m)	90
Diesel engine scraper and bulldozer (100-450 kW)	120
Diesel engine crawler loaders (40-60 kW)	110
Diesel engine excavator (45-80 kW)	105
Pneumatic concrete (36 kg)	110
Diesel engine crawler crane (40-60 kW)	105
Diesel engine trucks (1.2~2.5 ton)	100
Diesel engine vibrated cylinders (2 ~75 kW)	110
Concrete mixers	115
Concrete pumps	115
Grader	120
Rock driller	125
Compressor	115
Tractor	120
Loader	115
Gears	95
Electrical motors	105
Pumps	120

Leq : Noise level equivalent

Table A-6-5 Maximum Tolerable Noise Levels

Time of exposure to noise (hours/day)	Maximum noise level (dB A)
7.5	80
4	90
2	95
1	100
0.5	105
0.25	110
1/8	115

Maximum noise level for (stroke) shock noise is 40 dB A.

A-7 LIST OF DATA PROVIDED BY DSI

A-7 List of Data Provided by DSI

7.1 General

Item	Notes
1. The General Directorate of State Hydrolic Works	Issued by DSI 1983
2. Devlet Su Isleri Genel Mudurlugu	Issued by DSI 1985
3. General Directorate of State Hydrolic Works Research Center	Issued by DSI
4. General Directorate of State Hydrolic Works Technical Research and Quality Control Center	Issued by DSI
5. Geotechnical Services and Ground Water Activities	Issued by DSI 1986
6. Information on DSI Regional Activities	Issued by DSI 1987
7. Su sondajlari, Temel Sondajlari ve Enjeksiyon Isleri 1987 Birim Fiyat Cetveli	Issued by DSI 1987
8. Dams and Hydroelectric Power Plants in Turkey	Issued by DSI 1987
9. Hidroelektrik Santrallerin Kurulu Guclerine Gore Dagilimi	Issued by DSI 1987
10. Hidroelektrik Santrallerin Proje Durumlarina Gore Dagilimi	Issued by DSI 1987
11. Data of Electric Power Situation in Turkey	
12. Statistical Pocket Book of Turkey	Issued by DSI
13. Iller Projelef ve Barajjar	Issued by DSI
14. Enerji Raporu 1985	Issued by DEKTMK

7.2 Meteorology and Hydrological Data

Item		Notes
1.	1983 Water Year Discharges	Issued by EIE
2.	Aylik Ortalama Akimlar 1935 - 1980	Issued by EIE
3.	Ortalama, Ekstrem Sicaklik ve Yagis Degerleri 1984	Issued by EIE
4.	Precipitation Depth-Area-Duration Analyses for Kavsak Dam Project on Seyhan River 1977	Issued by DMI
5.	Sediment Data and Sediment Transport Amount for Surface Water in Turkey 1982	Issued by EIE
6.	Daily Discharge Data at EIE's Gauging Stations Nos. 1801, 1802, 1803, 1805, 1806, 1818, 1822	
7.	Discharge Observation Results and Daily Discharge Data at DSI's Gauging Stations Nos. 18-20, 18-21, 18-24, 18-25, 18-26	
8.	Water Level and Discharge Observation Data at EIE's No. 1826 Gauging Station	newest data (unevaluated)
9.	Water Level and Discharge Observation Data at the Goktas Dam Site	newest data (unevaluated) observed by DSI
10.	Water Level and Discharge Observation Data at EIE's No. 1805 Gauging Station	newest data (unevaluated)
11.	Daily Precipitation Data at DSI's and DMI's Meteorological Stations	DSI: Huseyinli, M. Basoren, Kazancik, Uzunpinar, Ergenusagi, Musahacili, Kamisli DMI: Seyhli, Tomarza, Pinarbasi, Karsanti, Mansurlu, Feke, Saimbeyli, Tufanbeyli, Sariz

Item	Notes
12. Monthly Precipitation Data at DSI's and DMI's Meteorological Stations	DSI: Huseyinli, Yedioluk, M. Basoren, Kazancik, Uzunpinar, Ortaca, Ergenusagi, Yardibi, Doganbeyli, Gerdekmagara DMI: Seyhli, Bakirdag, Tomarza, Toklar, Elbasi, Pazaroren, Pinarbasi, Kaynar, Orensehir, Karsanti, Mansurlu, Feke, Cokak, Seimbeyli, Tufanbeyli, Sariz, Yazyurdu, Altinyayla, Akkisla, Bunyan, Kayseri, Develi Yahyali, Camardi, Kozan, Andirin, Nigde, Pozanti, Adana
13. Monthly Snow Gauging Data at DSI's and DMI's Meteorological Stations	DSI: Yardibi, Doganbeyli, Gerdekmagara DMI: Bakirdag, Tomarza, Pazaroren, Pinarbasi, Kaynar, Orensehir, Mansurlu, Feke, Saimbeyli, Tufanbeyli, Sariz, Kayseri, Nigde
14. Daily Temperature Data at DMI's Meteorological Station	Pinarbasi
15. Monthly Temperature Data at DMI's Meteorological Stations	Tomarza, Pinarbasi, Feke, Sariz, Gemerek, Kayseri, Develi, Goksun, Adana
16. Monthly Evaporation Data at DSI's and DMI's Meteorological Stations	DSI: Uzunpinar, Gemerek, Musahacili DMI: Tomarza, Kayseri, Goksun, Adana
17. Monthly Relative Humidity Data at DMI's Meteorological Stations	Tomarza, Pinarbasi, Feke, Sariz, Pozanti, Adana
18. Monthly Vapor Pressure Data at DMI's Meteorological Stations	Tomarza, Pinarbasi, Feke, Sariz, Gemerek, Kayseri, Develi, Kozan, Goksun, Nigde, Pozanti, Adana, Ulukisla, Tarsus

Item	Notes
19. Monthly Wind Measurement Data at DMI's Meteorological Stations	Kayseri, Develi, Goksun, Pozanti, Adana, Karaisali
20. Meteorological Data of Historical Storms	Precipitation, Vapor pressure, Weather Charts
21. Turkiyede Maksimum Yagislarin Frekans Atlasi	Issued by DSI 1970

7.3 Geology, Materials, and Seismicity

Item	Notes
1. Seyhan-Kavsak Baraj Yeri (B) Muhendislik Jeolojisi Sonuc Raporu Feb. 1980 EIE	Issued by EIE
2. Kavsak and Catalan Projects Preliminary Report Sep. 1978	Issued by Verbundplan, Romconsult & Temelsu
3. Seyhan-Kavsak Rezervuari, Zamanti Sag Sahili Jeoloji Raporu Jan. 1977	Issued by EIE
4. Kavsak and Catalan Projects "Upper Development" Additional Layouts for Briefing in Ankara Nov. 1978	Issued by Verbundplan, Romconsult & Temelsu
5. Geological Maps of Turkey 1/500,000 "Adana" and "Kayseri"	Issued by MTA
6. Turkiye Jeoloji Haritalari Serisi Kozan-J20 Paftasi 1/100,000	Issued by MTA
7. Goktas Baraji Hes Yeri ve Cebri Boru Guzergahi Sismik Refraksiyon Etudu	Issued by DSI
8. Goktas Baraj Yeyi "Deprenrisk Analizi" Raporu	Issued by DSI
9. Plate Bearing Test Data Sheet (6 point)	Issued by DSI
10. Result of Laboratory Test for Concrete Material (QU-1, RD-1, RD-2)	Issued by DSI
11. Result of Laboratory Test for Drilling Core (Dam Site, Tunnel Route, and Power Plant Site)	Issued by DSI

7.4 Power System

Item		Notes
1.	Hidroelektrik Santrallerin DSI Boigelerine Gore Dagilimi (Jan. 1987)	Issued by DSI
2.	Hidroelektrik Santrallerin Proje Durumlarina Gore Dagilimi (Jan. 1987)	Issued by DSI
3.	Turkiye Elektrik Dagitim Muessesleri (1987)	Issued by TEK
4.	WASP Modeli Ile Turkiye 1993 - 2010 (1987)	Issued by TEK
5.	Turkiye Uretim - Tuketim Incelenmesi (1987)	Issued by TEK
6.	Electrification Map of Turkey 1987	Issued by TEK
7.	Turkiye Elektrik Enerjisi Istatistikleri	Issued by DSI
8.	Turkiye 1986 Yili Kurulu Guc ve Brut Elektrik Enerjisi Arzi, 1982 - 2000	Issued by DSI
9.	Turkiye Uretim-Tuketim Incelenmesi (1989 - 1993) (Turkey Supply & Demand Investigation)	Issued by TEK
10.	Ithal Edilen Enerjisinin (Imported Electric Energy)	Issued by TEK
11.	Daily & Monthly Load Curve	Issued by TEK
12.	Transmission Tower and Line Construction Cost & Impedance	Issued by TEK
13.	Single-Line Diagram of the 420 kV Network in the Year of 1993	Issued by TEK
14.	Turkish Electricity Authority Annual Report '86	Issued by TEK
15.	Power Flow Map in 1990	Issued by TEK
16.	Monthly Electric Consumptions of Turkey in 1987	Issued by TEK

Item	Notes
17. 1987 Annual Report - Cukrova Elektrik A.S.	Issued by CEAS
18. Facilities owned by Cukrova Power Company	Issued by CEAS
19. Present Situations of Power (kW) and Energy (kWh) Demands	Issued by CEAS
20. Cukrova Elektrik A.S. - Power Demand Forecast	Issued by CEAS
21. Cukrova Elektrik A.S. - Plan for Development Power Plant up to 2004	Issued by CEAS
22. Transmission Line Impedance in Cukrova System	Issued by CEAS
23. Annual Load Duration Curve	Issued by CEAS
24. Typical Daily Load Curve for 1986	Issued by CEAS

7.5 Electrical Equipment

Item	Notes
1. 60 Gross Tons Floating Crane General Arrangement	submitted by Mersin Port
2. Site Arrangement General Site Plan (Ataturk No. 7.1)	submitted by DSI
3. Dam and Cofferdams General Layout (Ataturk No. 10.1)	submitted by DSI
4. 380 kV Transmission lines General Layout and Towers Disportion (Ataturk No. 14.2.2)	submitted by DSI
5. Powerhouse Cross Section B-B (Ataturk No. 14.2.22)	submitted by DSI
6. Powerhouse Plan View (Ataturk No. 14.2.16)	submitted by DSI
7. Switchyard General Layout (Ataturk No. 16.1.1)	submitted by DSI
8. Main Single-Line Diagram (Ataturk No. 14.3.2)	submitted by DSI
9. Schematic Diagram of Cooling Water System of Two Adjacent Main Units (Ataturk No. 14.2.5)	submitted by DSI
10. Enerji Nakil Hatlary (ERB) Icin 1988 Yili Bird Fiyatlari Sonuc Tablosu (Table of Construction Cost for Lines)	submitted by DSI
11. Buz Yuku Haritasi (Zone of Construction Cost for Lines)	submitted by DSI

7.6 Construction Planning and Cost Estimation

Item	Notes
1. Birim Fiyat Cetveli 1987 - DSI	Issued by DSI
2. Kargi Baraji ye Hidroelektrik Santrali Proje Raporu Cilt : 9	Issued by DSI
3. Ilisu Dam and Hydroelectric Power Plant Project Design Reports Vol. II Construction Cost	Issued by DSI
4. Oymapinar Project Price Schedule	Issued by DSI
5. 1988 Yilna Ait Insaat Birim Fiyatlarina Esas Iscilik-Arac ve Gerec Rayic Listeleri	Bayindirlik ve Iskan Bakanligi
6. DSI 1988 Yili - Birim Fiyat Cetveli	Issued by DSI
7. DSI Birim Fiyat Tarifleri	Issued by DSI
8. Birim Fiyat Cetveli 1988	Issued by DSI
9. Birim Fiyat Cetveli (Tarifleri ve Sartlare)	Issued by DSI
10. Su Sondajlari Temel Sondajlari ve Enjeksiyou Isleri 1988 Birim Fiyat Cetveli	Issued by DSI
11. Su Sondajlari Temel Sondajlari ve Enjeksiyou Isleri Birim Fiyat Tarifleri	Issued by DSI
12. Birim Fiyat Analizleri	Issued by DSI
13. Zamanti-Goktas Hes Projesi Kamulastirma Planlama Raporu	Issued by DSI
14. 1983 Akim Gozlem Yilligi	Issued by DSI
15. Conversation Factors for 1988 Prices	Issued by DSI
16. Information on DSI Regional Activities	DSI 6th (Adana)

7.7 Economy

Item	Notes
1. TEK, Elektrik Dagi Muesseselesi Satis Tarifesi	Issued by TEK
2. TEK, Uretim-Iletim Muesseselesi Satis Tarifesi	Issued by TEK
3. TEK, Faaliyet Raporu '86	Issued by TEK
4. TEK, Annual Report '86	Issued by TEK
5. 1987 Annual Report - Cukrova Elektrik A.S.	Issued by CEAS
6. Calisan Santrallarin Fili Uretimi, Yillik Giderler 1987 Yili Degerleri Tablosu	Issued by DSI

7.8 Environment

Item	Notes
1. Animals and Vegetation List	Issued by DSI
2. Biological Monitoring - Macroinvertebrate Data	Issued by DSI
3. The Relationship between Biological Scores and NWC Classes	Issued by DSI

7.9 Master Plan Report for Seyhan River Basin Prepared by DSI

Item	Notes
1. Lower Seyhan Basin Master Plan Vol. I	General Engineering
2. Lower Seyhan Basin Master Plan Vol. II	Drawings
3. Lower Seyhan Basin Master Plan Vol. III	Engineering Hydrology
4. Lower Seyhan Basin Master Plan Vol. IV	Geology
5. Yukari Seyhan Havzasi Master Plan Raporu Ozet Raporu	Summary
6. Yukari Seyhan Havzasi Master Plan Raporu Cilt:1 Metinler	Text
7. Yukari Seyhan Havzasi Master Plan Raporu Cilt:2 Cizimler	Drawings
8. Yukari Seyhan Havzasi Master Plan Raporu Cilt:3 Hidroloji	Hydrology

7.10 Maps

Item	Notes
1. Division Area Map of 6th (Adana) Division of DSI	1/250,000
2. Division Area Map of 7th (Kaiseri) Division of DSI	1/250,000
3. Location Map for Dam Site, Powerhouse Site, Borrow Area Site, and Access Load	1/100,000; prepared by DSI
4. Topographical Map of the Goktas Project Area	1/5,000; 34 Sheets, drawn by DSI
5. Topographical Map of the Goktas Dam Site Area	1/1,000; 10 Sheets, drawn by DSI