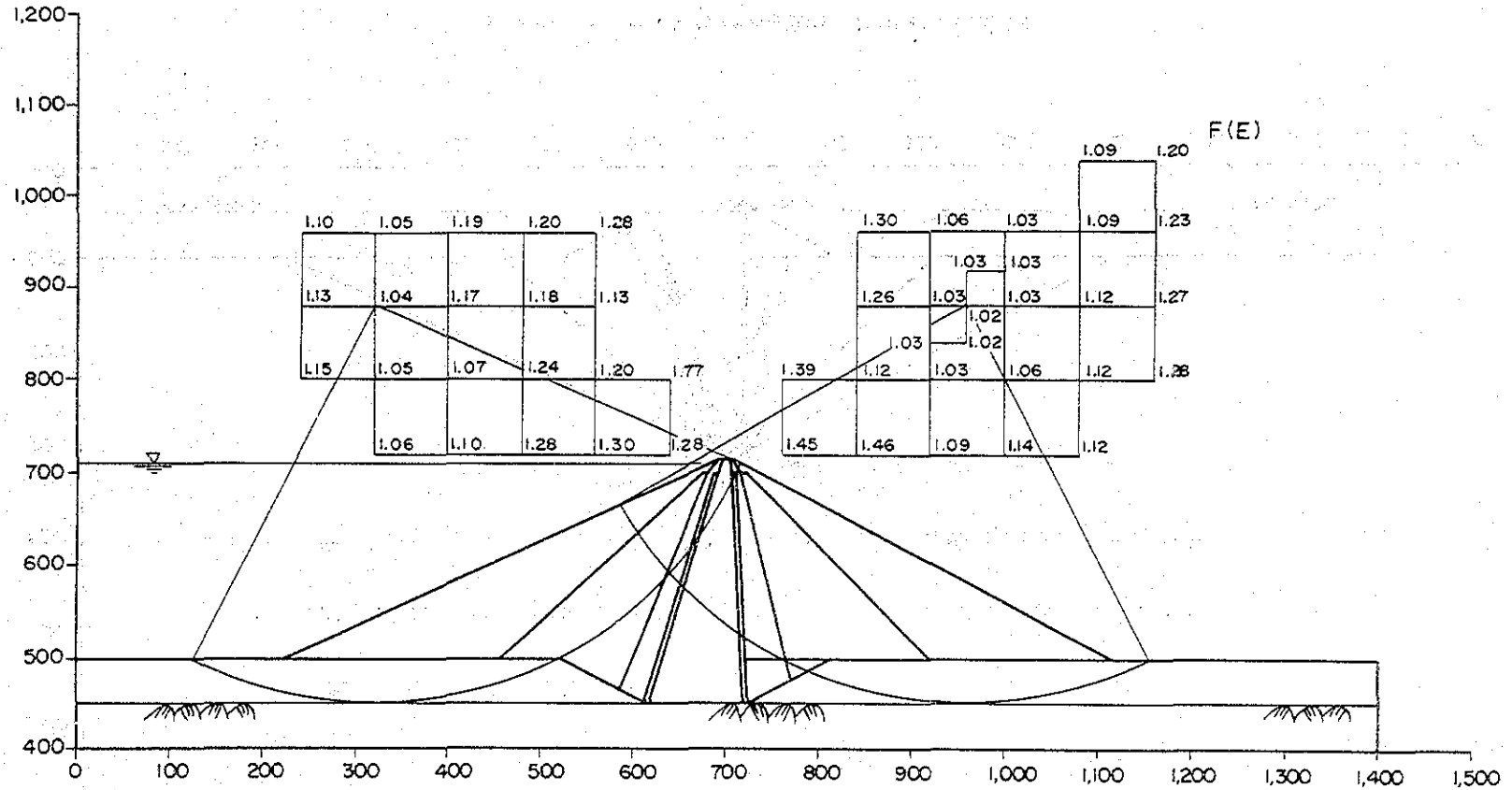


Fig. AP.4–5 Normal High Water Level, Seismic Condition

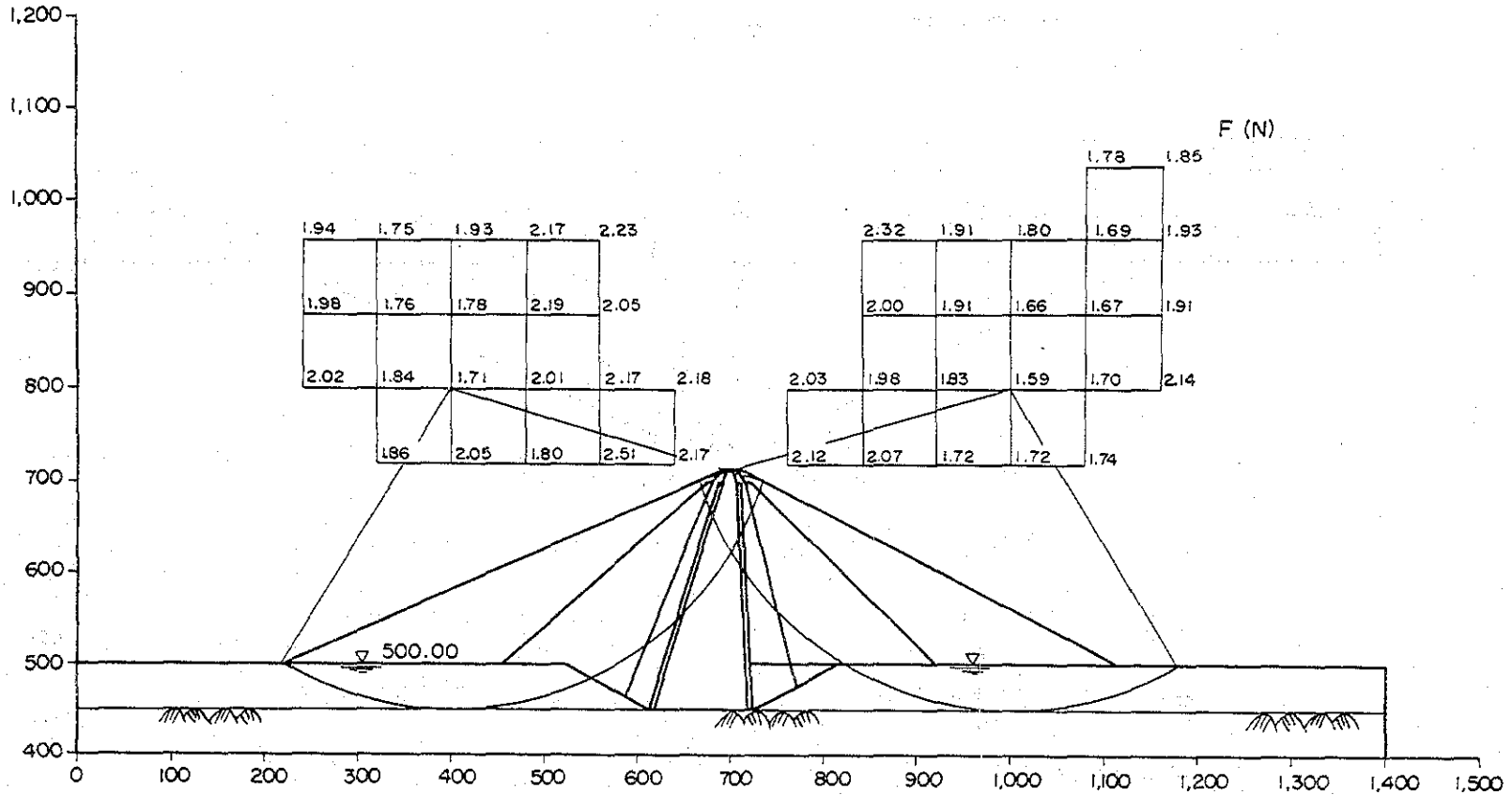


Fig. AP.4–6 Work Completion, Normal Condition

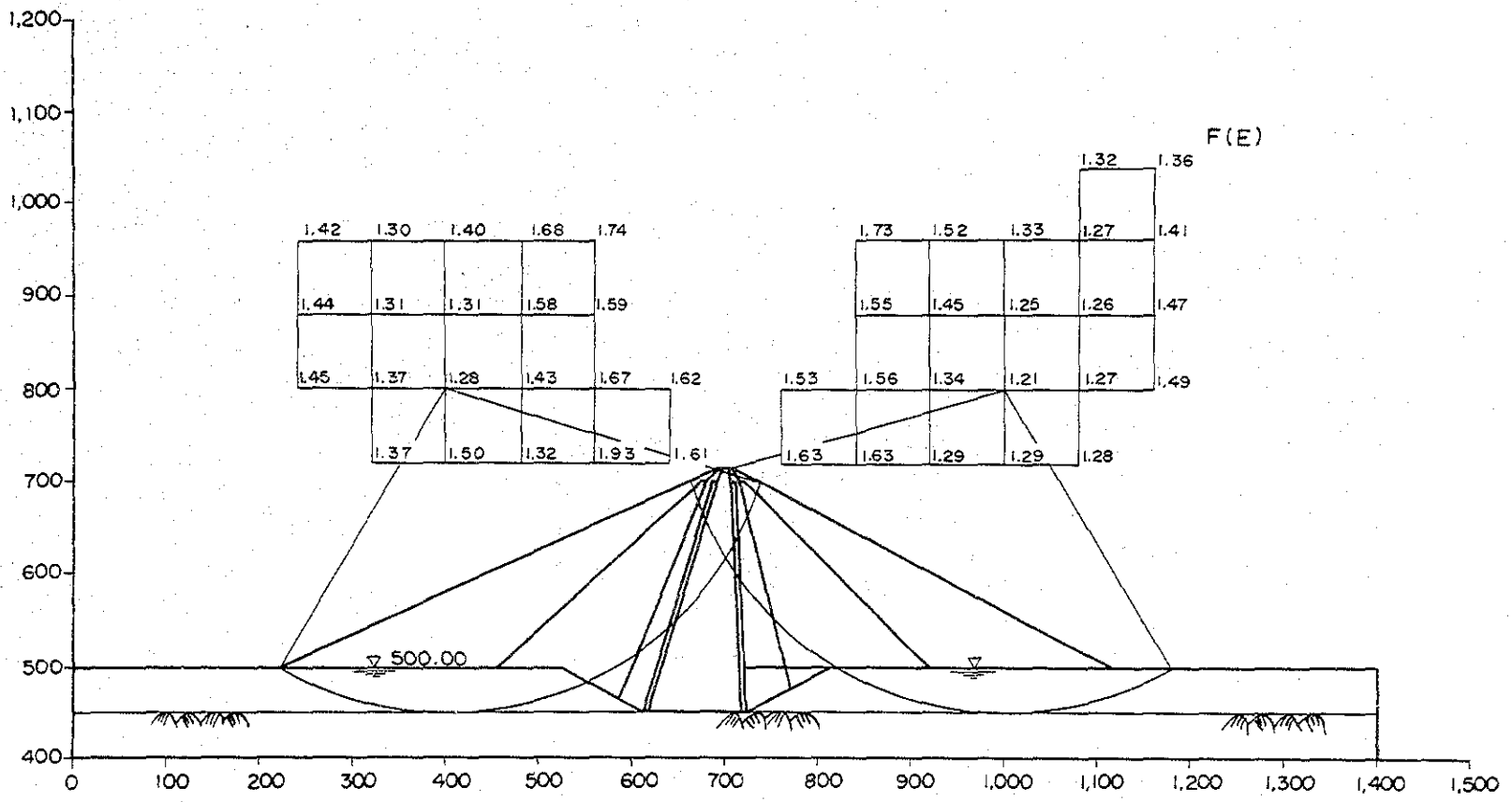


Fig. AP.4–7 Work Completion, Seismic Condition

4. 3 Stress Analysis of Artvin Dam

4.3 Stress Analysis of Artvin Dam

4.3.1 General

Stress analysis has been performed for the Artvin arch dam by Trial load method. In the analysis, normal and earthquake conditions are considered.

4.3.2 Basic Concept and Equations

In this method, basic assumption is that an arch dam is composed of arch elements and cantilever elements (as shown in the Fig. AP.4-8) and that acting loads are to be born by both arch and cantilever elements where deflections taken place at a grid point formed by the elements are equal due to the continuity of the body.

In the analysis, "radial adjustment computation" where only the radial deflection is to be adjusted equal was performed.

Following is a basic equations to be realized in the computation.

$$cr(\Delta\gamma)m,n = ar(\Delta\gamma)m,n$$

$$crPm,n + arPm,n = Pm,n$$

,where

$\Delta\gamma$: Delfection

P : Load acting to the grid point denoted by (m,n)

Sufices are; cr: Cantilever
ar: Arch
m,n: Grid point of cantilever m and arch n

Fig. AP.4-9 is to be referred.

4.3.3 Calculation Condition

1) Design condition

Dam Crest Elevation	505.00 m
High Water Level	500.00 m
Sediment Level	413.00 m
Foundation Elevation	345.00 m
Water Level in Earthquake	500.00 m
Downstream Water Level	395.00 m

2) Physical properties

Symbol	Physical property	Unit	Value
Ec	Elastic modulus of concrete	t/m^2	$2{,}000 \times 10^3$
E_R	Elastic modulus of bed rock (Left bank)	t/m^2	450×10^3
	(Right bank)	t/m^2	250×10^3
Gc	Shear elastic modulus of concrete	t/m^2	830×10^3
c	Poisson's ratio of concrete	-	0.2
R	Poisson's ratio of bed rock	-	0.2
K_R	Ratio of deflection in radial direction due to actual shear distribution against due to assumed uniform shear distribution	-	1.25
Ks	Ratio of delfeciton in tangential direction due to actual shear distribution against due to assumed uniform shear distribution	-	1.00
Wc	Unit weight of concrete	t/m^3	2.35
Ww	Unit weight of water	t/m^3	1.0
Ws	Unit weight of sediment	t/m^3	1.1
C	Thermal expansion coeff. of concrete	1/°C	1×10^{-5}

3) Load condition

Considered loads are dead weight, hydrostatic pressure, sediment pressure, uplift, temperature loads and seismic forces.

① In calculating hydrostatic pressure and uplift, water level of upstream was taken to be 505.00 equal to the dam crest so as to keep the design in safety side, which should take place in case of land sliding at Havuzlu or other upstream location.

② Sesiment pressure was calculated by;

$Ps = CsWshs$

where $Cs = 0.4$

③ Temperature loads were computed in accordance with the following temperature variation.

El. (m)	Temp. lowering (°C)
505.00	-6.0
488.50	-5.0
455.00	-4.0
425.00	-3.0
395.00	-2.5
365.00	-2.0
345.00	-2.0

④ Uplift was assumed to be simple gradient between upstream and downstream pressure which corresponds to each water level.

⑤ Hydrodynamic pressure was calculatead with the Westerguard's equation.

$$Pd = \frac{7}{8} WwK.H.h$$

Seismic coefficient (K) was taken to be 0.3.

4.3.4 Result

The calculation has been performed by a computer. The result is summarized in the following table and figures.

Case	EL.(m)	Maximum Stress (kg/cm^2)	
		Vertical (cantilever)	Horizontal (Arch)
Normal Condition	488.50	10.2	46.8
	455.00	24.1	58.3 (cr)
	425.00	35.0	65.6 (cr)
	395.00	40.7	62.3 (cr)
	365.00	43.9	53.0 (cr)
	345.00	44.0	42.5 (cr)
Seismic Condition	488.50	14.3	86.7
	455.00	31.4	93.2 (cr)
	425.00	54.0	86.8 (cr)
	395.00	60.4	87.3 (cr)
	365.00	60.6	71.2 (cr)
	345.00	57.8	55.1 (cr)

From the result, all the stresses are within an usual allowable stress, i.e.

Normal condition $\sigma aN = 70\ kg/cm^3$

Seismic condition $\sigma aS = 100\ kg/cm^3$

In further stage, however, more detail analyses such as FEM or model tests should be performed taking the foundamental properties of material to be actually used.

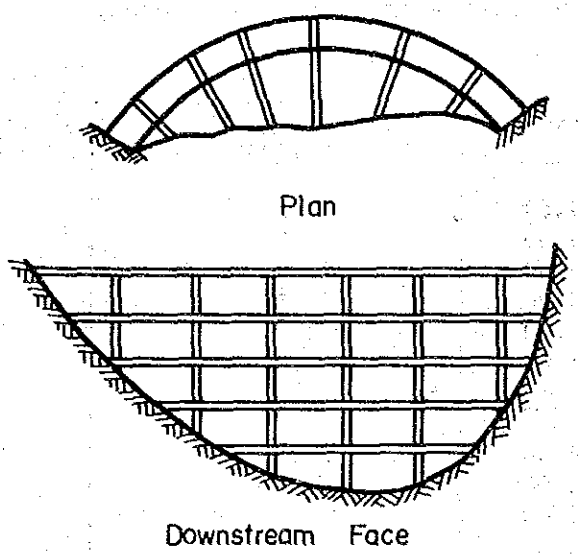


Fig. AP.4–8 Arch and Cantilever Elements

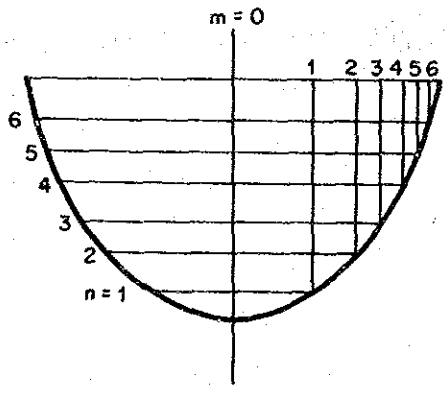
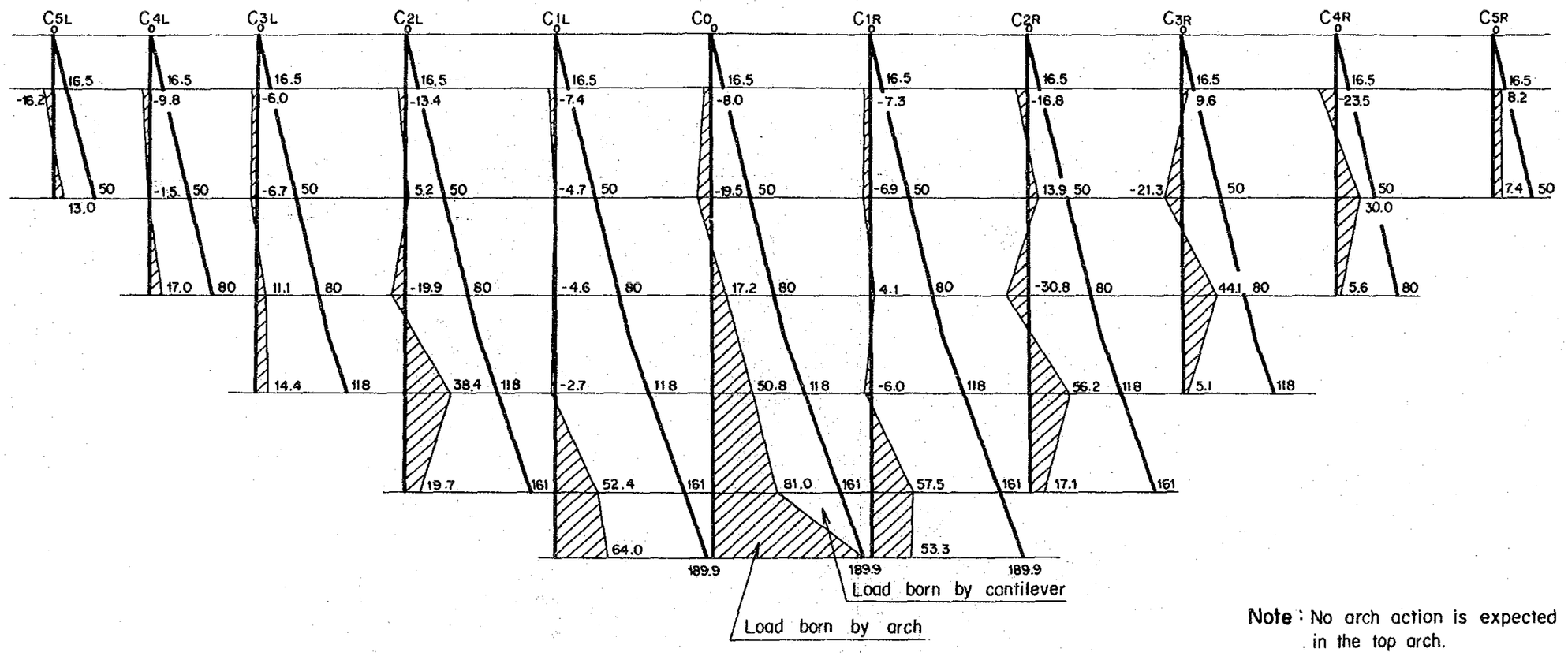


Fig. AP.4–9 Numbering of Grids



Note : No arch action is expected in the top arch.

Fig. AP.4–10 Load Share by Arch or Cantilever Element (Normal Condition)

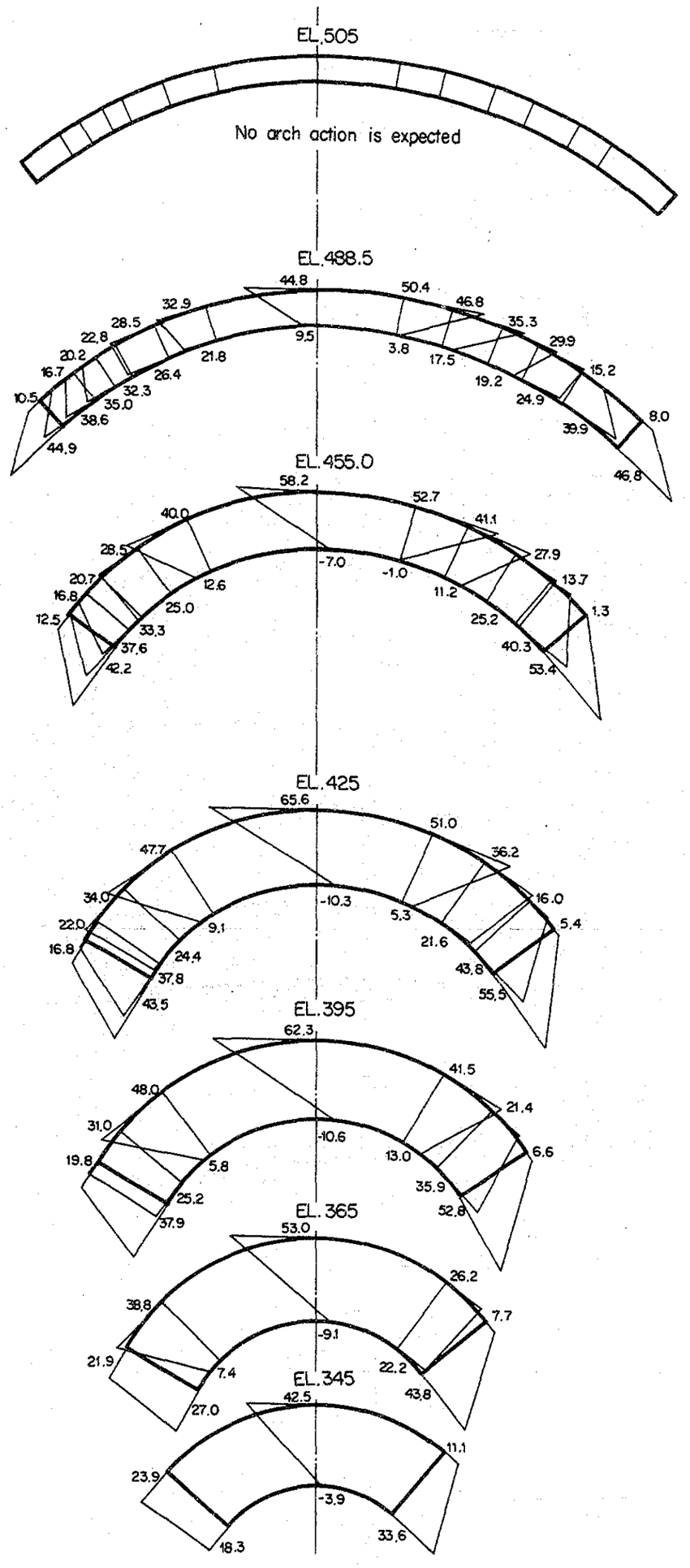


Fig. AP.4–11 Distribution of Horizontal Stresses (Normal Condition)

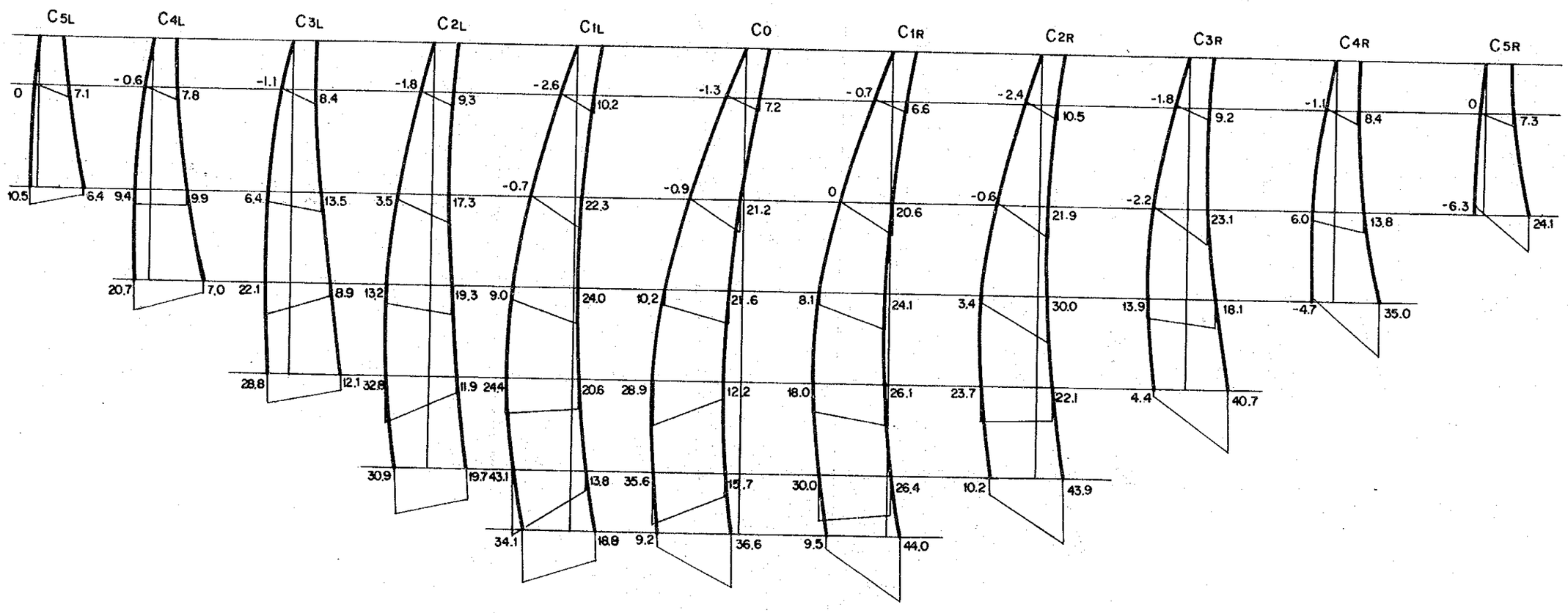
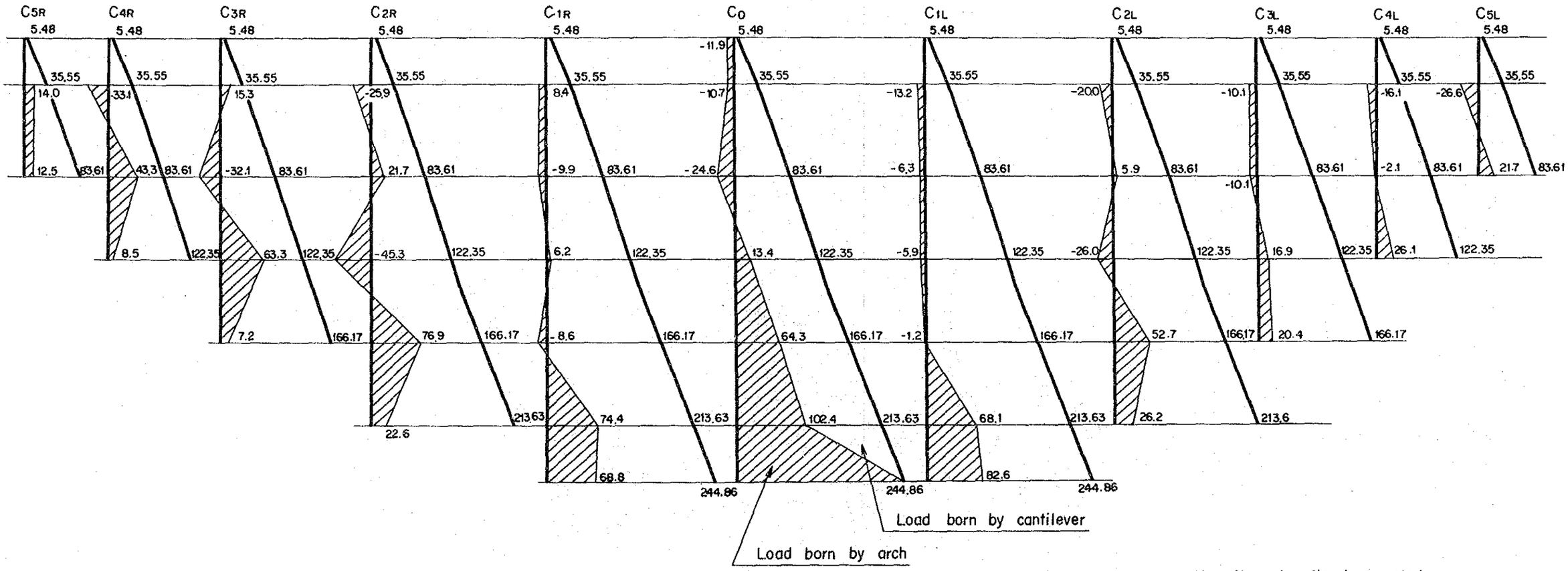


Fig. AP.4–12 Distribution of Vertical Stresses (Normal Condition)



Note: No arch action is expected in the top arch.

Fig. AP.4–13 Load Share by Arch or Cantilever Element (Seismic Condition)

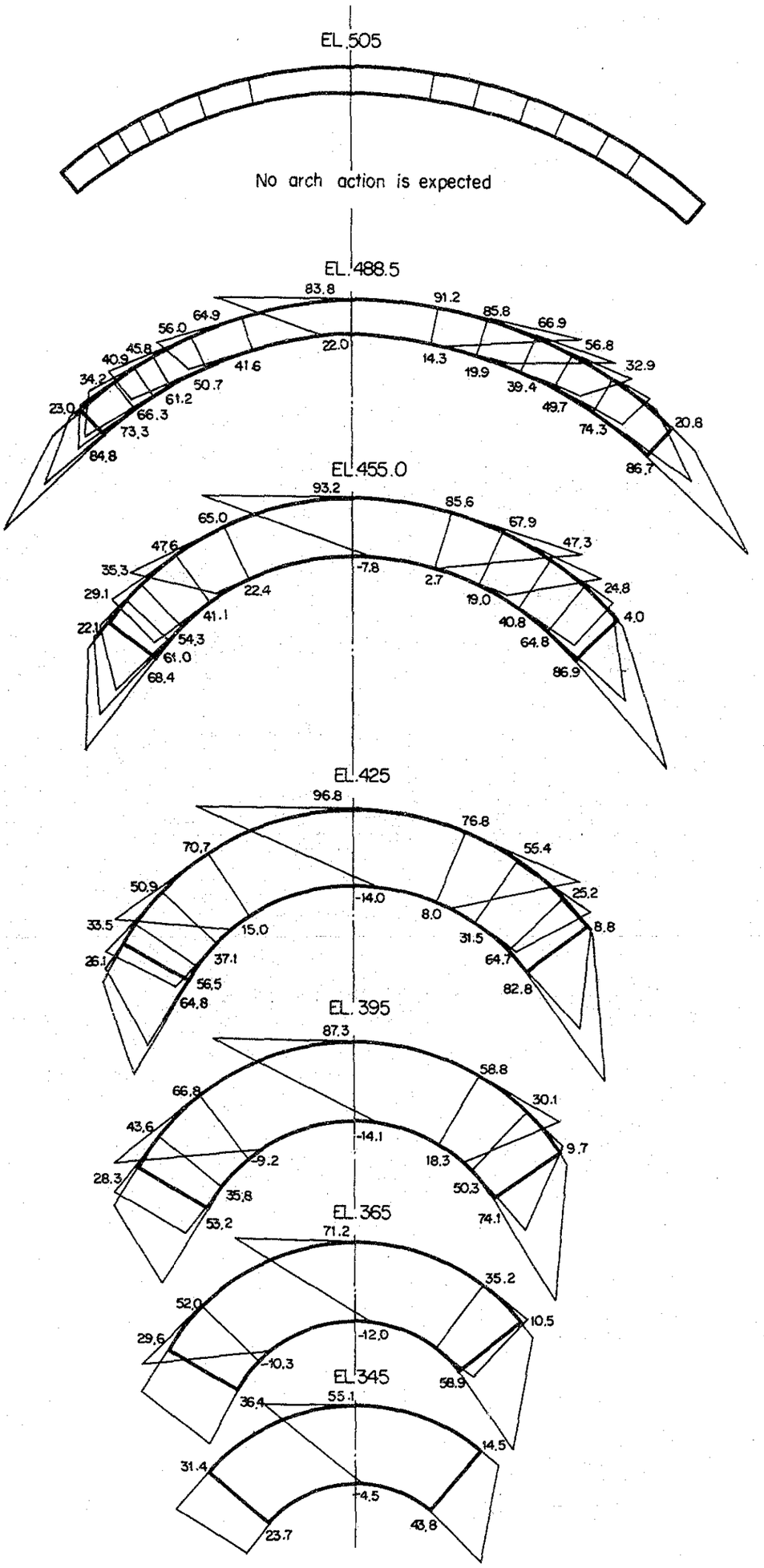


Fig. AP.4—14 Distribution of Horizontal Stresses (Seismic Condition)

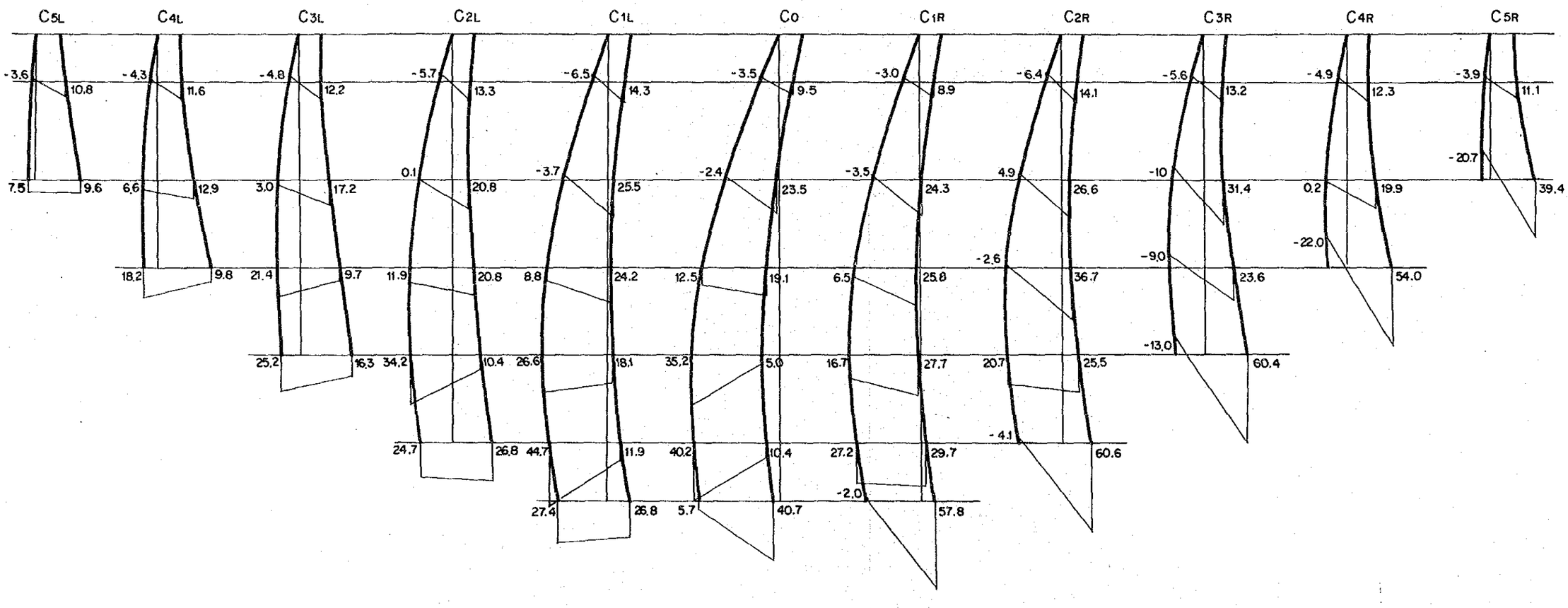


Fig. AP.4–15 Distribution of Vertical Stresses (Seismic Condition)

4. 4 River Profile and Cross Sections

1985 YILI
ÇORUH NEHRİ
YUSUFELİ-İNANLI
NEHİR SU YÜZÜ BOY
KESİTİ

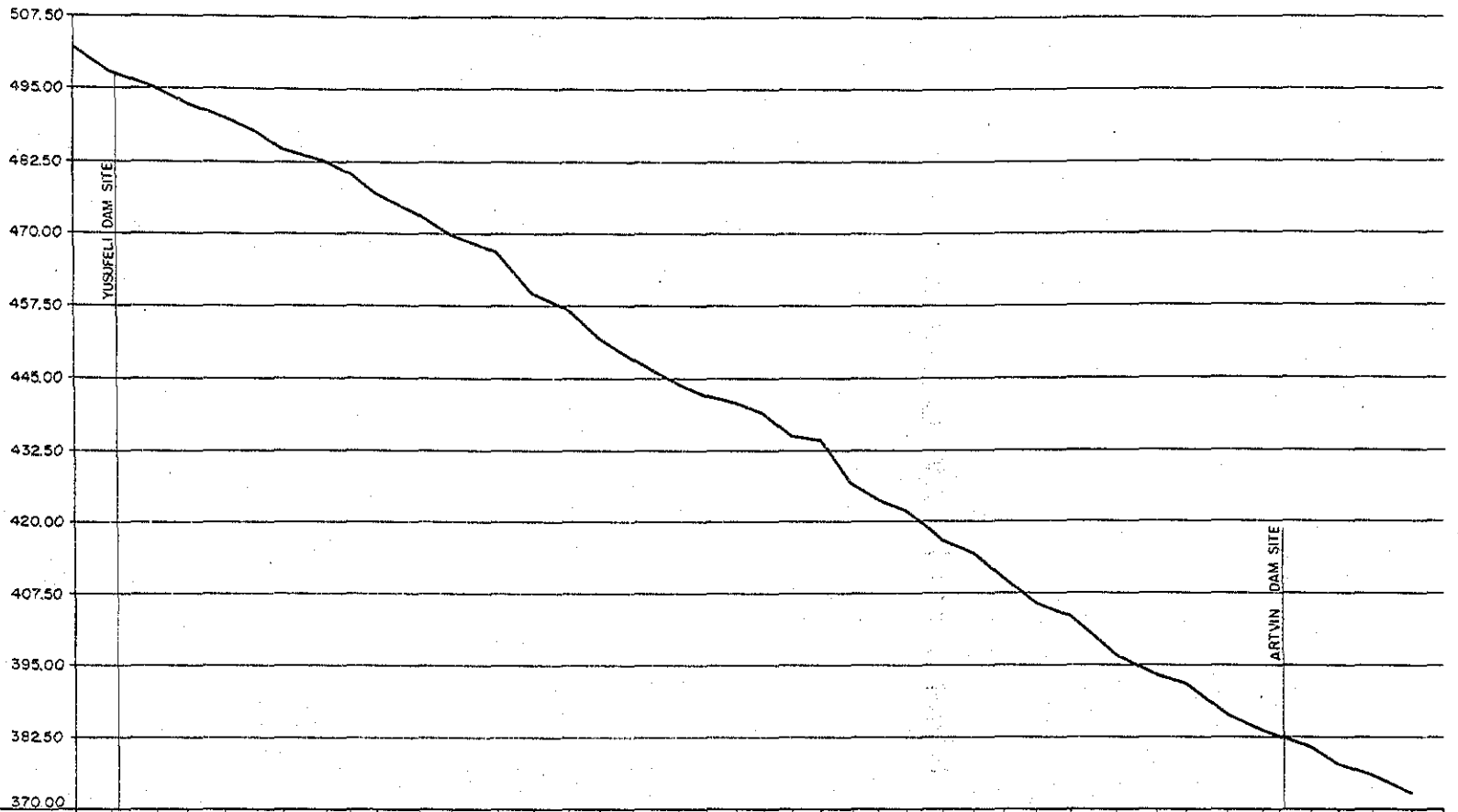
YEAR 1985
ÇORUH RIVER
YUSUFELİ-İNANLI
WATER SURFACE PROFILE
ALONG RIVER

1/250

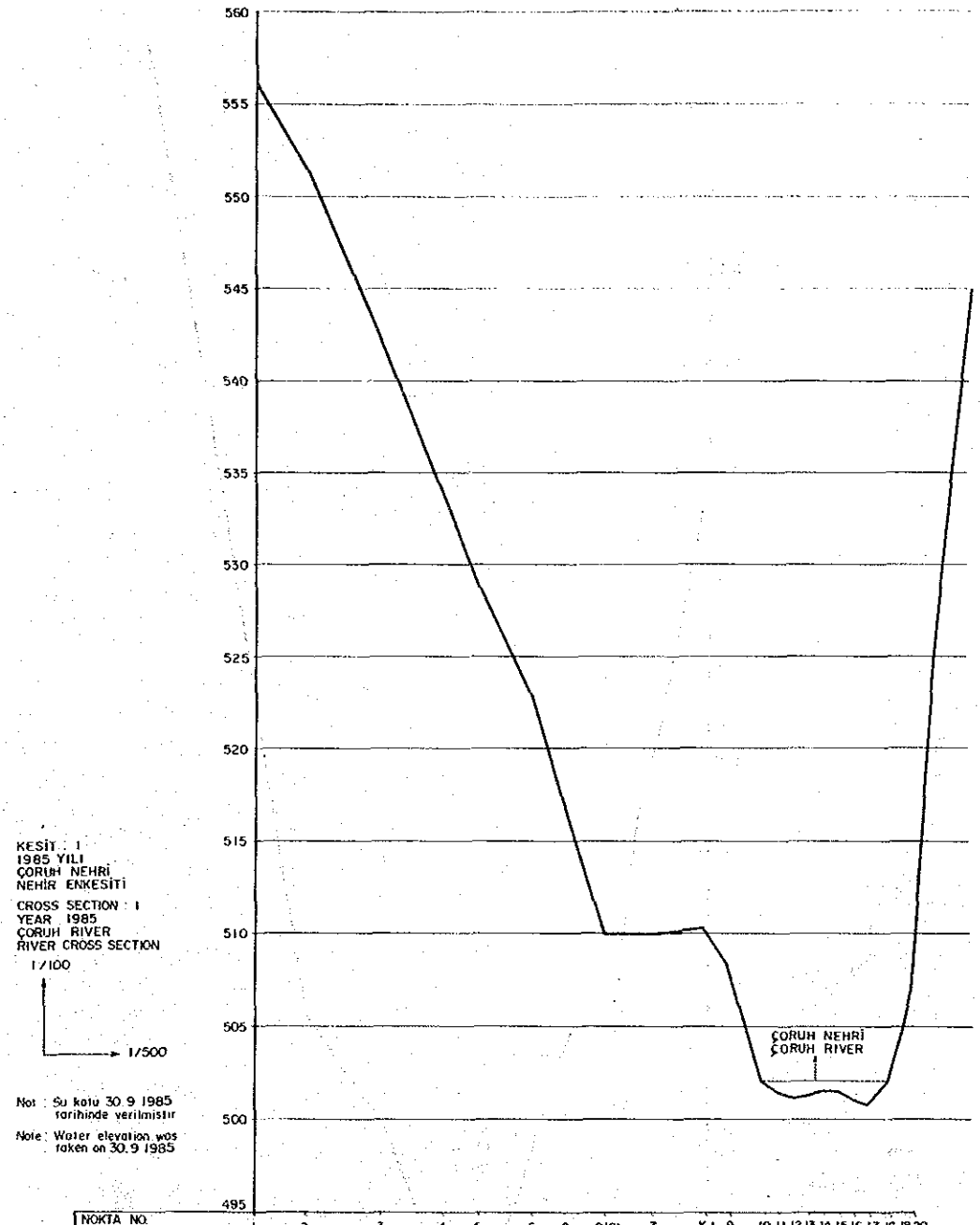
1/25.000

Not : Kesit 1 den Kesit 30 a kadar 30. 9. 1985 tarihinde, SU. 1 den SU.11 e kadar 1. 10. 1985 tarihinde su kotu verilmistir.

Note: From section 1 to section 30, elevation was taken on 30.9.1985 and from "SU.1" to "SU.11" on 1.10.1985



NOKTA NO. / POINT NO.	Kesit 1 su	Kesit 2 su	Kesit 3 su	Kesit 4 su	Kesit 5 su	Kesit 6 su	Kesit 7 su	Kesit 8 su	Kesit 9 su	Kesit 10 su	Kesit 11 su	Kesit 12 su	Kesit 13 su	Kesit 14 su	Kesit 15 su	Kesit 16 su	Kesit 17 su	Kesit 18 su	SU 1	SU 2	SU 3	SU 4	SU 5	SU 6	SU 7	SU 8	SU 9	SU 10	SU 11	Kesit 19 su	Kesit 20 su	Kesit 21 su	Kesit 22 su	Kesit 23 su	Kesit 24 su	Kesit 25 su	Kesit 26 su	Kesit 27 su	Kesit 28 su	Kesit 29 su	Kesit 30 su
ARA MESAFE / DISTANCE BETWEEN POINTS		640.00	170.00	785.00	525.00	650.00	557.50	450.00	750.00	405.00	430.00	750.00	555.00	820.00	602.50	607.50	535.00	597.50	795.00	500.00	502.50	497.50	497.50	500.00	540.00	455.00	500.00	625.00	542.50	515.00	552.50	597.50	790.00	700.00	500.00	742.50	592.50	302.50	190.00	552.50	470.00	600.00	667.50	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	00.00	640.00	1 425.00	1 950.00	2 600.00	3 157.50	3 607.50	4 357.50	4 762.50	5 192.50	5 942.50	6 497.50	7 317.50	7 920.00	8 527.50	9 062.50	9 660.00	10 455.00	10 955.00	11 457.50	11 955.00	12 452.50	12 952.50	13 492.50	13 947.50	14 447.50	15 072.50	15 615.00	16 130.00	16 682.50	17 280.00	18 070.00	18 770.00	19 270.00	20 012.50	20 605.00	20 907.50	21 460.00	21 930.00	22 530.00	23 197.50	
KOTLAR / ELEVATION	502.01	497.87	494.98	492.43	490.08	487.63	484.77	482.57	480.54	477.13	473.37	469.84	466.83	459.60	456.97	451.73	448.26	444.02	441.97	440.84	439.15	435.08	434.34	426.72	423.94	421.97	416.61	414.39	410.14	405.63	403.68	396.51	393.20	391.78	386.25	383.56	382.49	380.84	377.92	375.76	372.99	



KESİT : 1
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 1
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

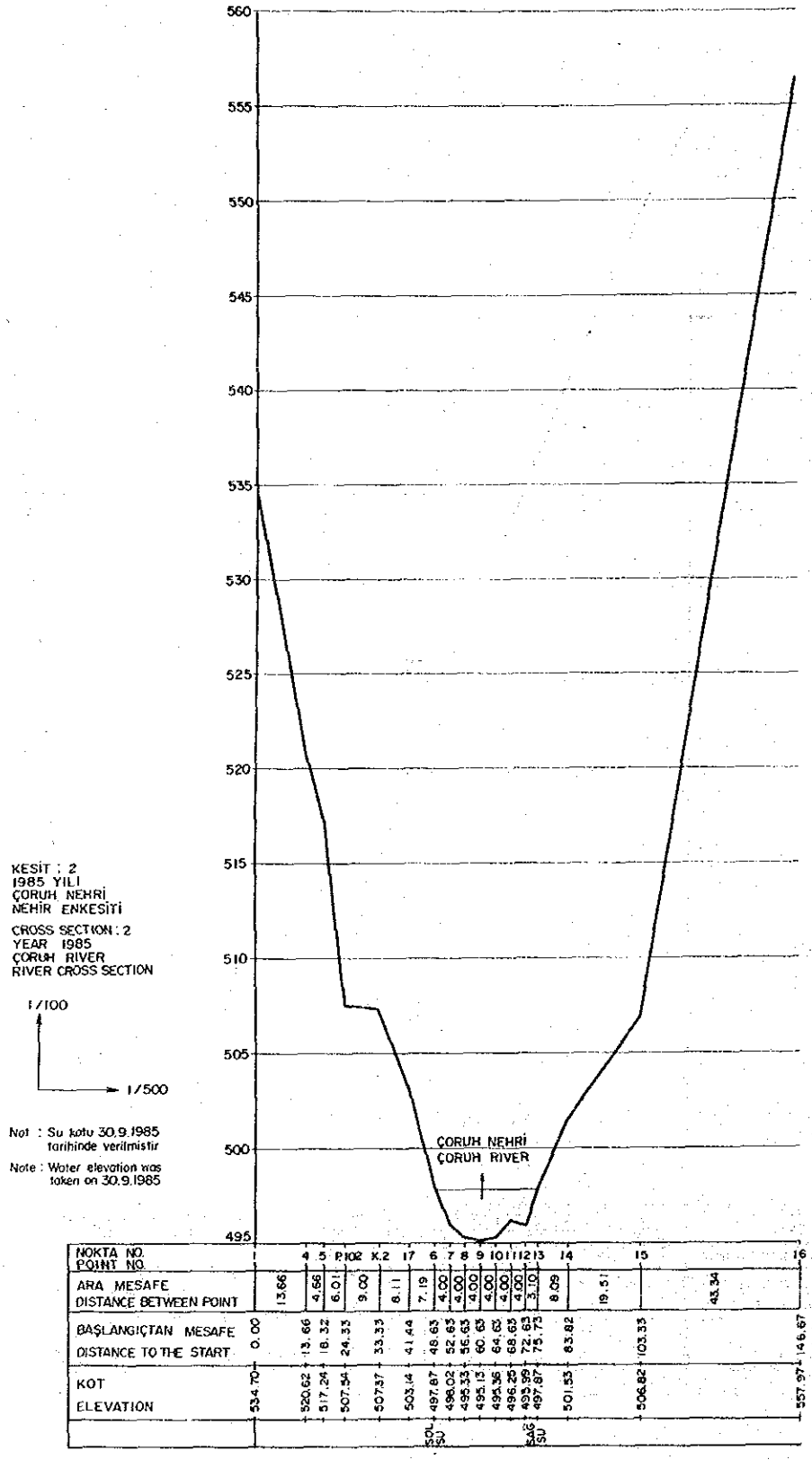
1/100

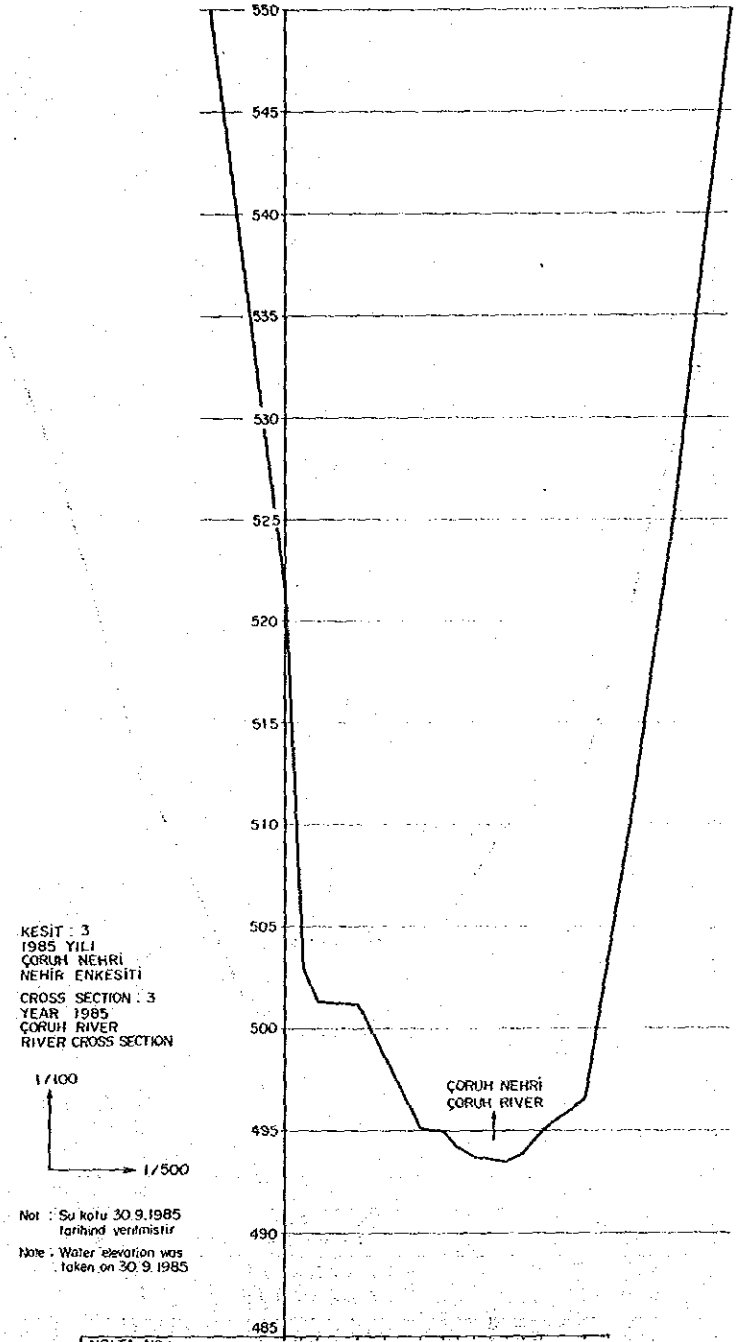
1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO POINT NO	1	2	3	4	5	6	8	8'101	7	K.I	9	10	11	12	13	14	15	16	17	18	19	20
ARA MESAFE DISTANCE BETWEEN POINT		13.81	20.46	17.24	9.90	14.64	8.85	11.03	13.02	14.96	6.74	9.26	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.50	4.07	2.31
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START	0.00	13.81	34.27	51.51	61.41	76.05	84.90	95.93	108.95	123.91	130.65	139.91	143.91	147.91	151.91	155.91	159.91	163.91	167.91	173.41	177.48	179.79
KOT ELEVATION	556.06	551.48	542.16	533.82	528.96	522.76	516.75	509.96	509.90	510.26	508.41	502.01	501.40	501.19	501.26	501.53	501.50	501.06	500.75	502.01	504.74	506.94
												SOL SU								SAĞ SU		


560
555
550
545
540
535
530
525
520
515
510
505
500
495
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 2
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 2
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. / POINT NO. 1 4 5 P102 X.2 17 6 7 8 9 10 11 12 13 14 15 16
ARA MESAFE / DISTANCE BETWEEN POINT 13.66 4.66 6.01 9.00 8.11 7.19 4.00 4.00 4.00 4.00 4.00 4.00 3.10 8.09 19.51 43.34
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START 0.00 13.66 18.32 24.33 33.33 41.44 48.63 52.63 56.63 60.63 64.63 68.63 72.63 75.73 83.82 103.33 146.67
KOT / ELEVATION 534.70 520.62 517.24 507.54 507.37 503.14 497.87 498.02 495.33 495.13 495.36 496.25 495.99 497.87 501.53 506.82 557.97
SOL SU
SAĞ SU



KESİT : 3
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 3
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

1/100

1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO / POINT NO	1	2	P1	03	K3	3	4	5	6	7	8	9	10	12	13	14
ARA MESAFE / DISTANCE BETWEEN POINT	4.40	3.90	0.00	10	6.80	8.30	5.10	4.00	4.00	4.00	4.00	4.00	4.19	10.71	6.20	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	4.40	8.30		18.30	25.10	34.00	39.10	43.10	47.10	51.10	55.10	59.10	63.29	74.00	80.20
KOT / ELEVATION	521.44	502.97	501.28		501.17	498.54	495.10	494.98	494.22	493.74	493.59	493.50	493.92	494.98	496.53	503.96
								SOL SU					SAĞ SU			

KESİT : 4
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

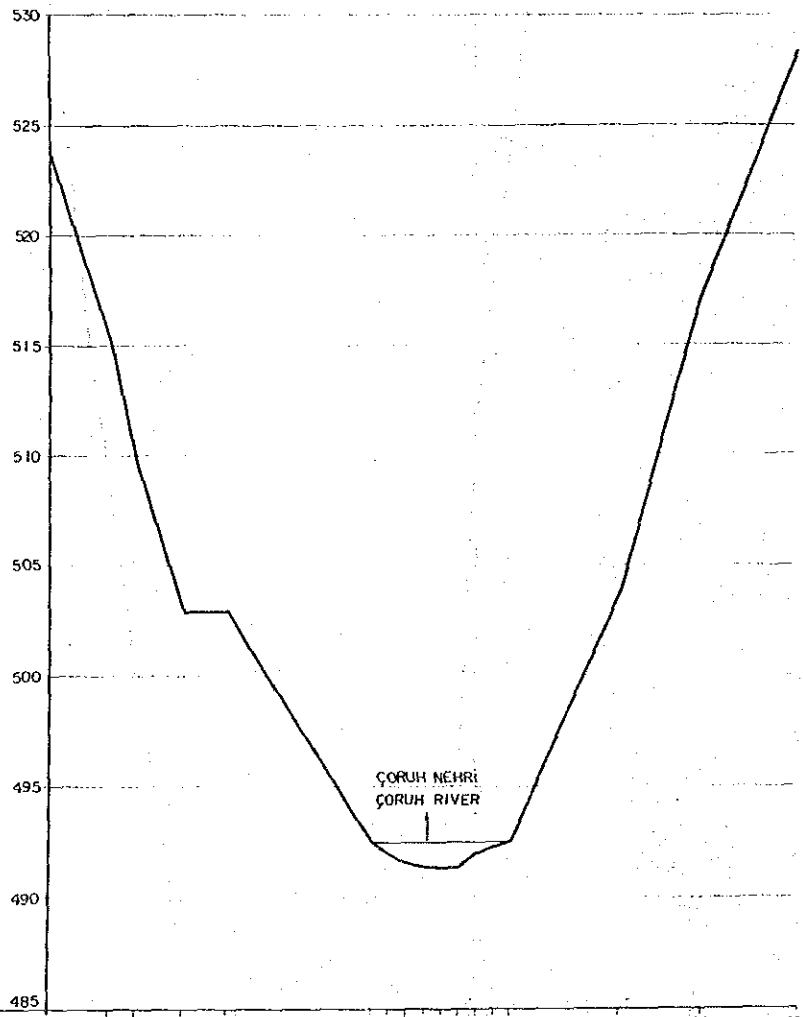
CROSS SECTION : 4
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

1/100

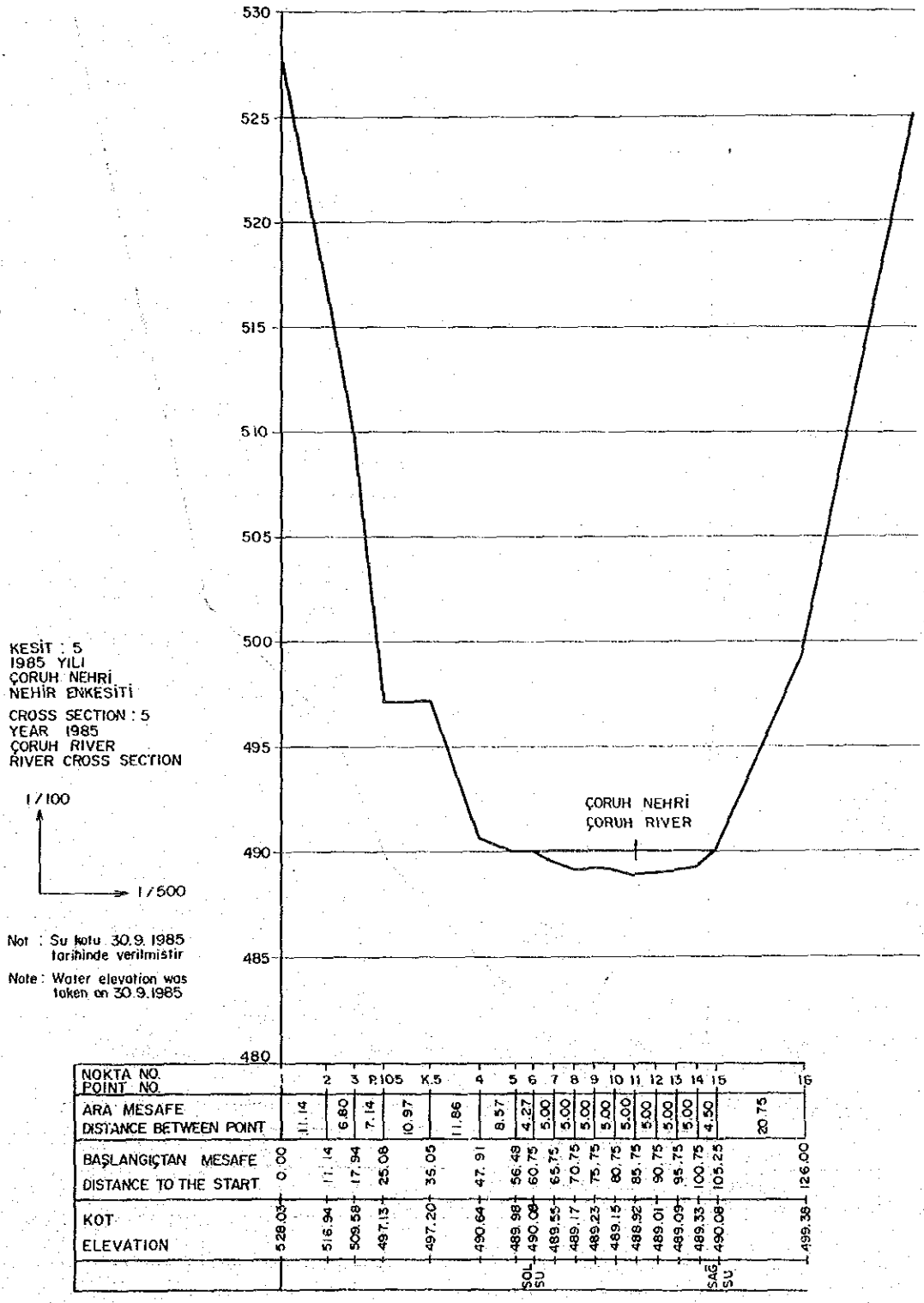
1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985



NOKTA NO / POINT NO	2	3	4	P.104	K4		5	6	7	8	9	10	11	12	13		14	15	16
ARA MESAFE / DISTANCE BETWEEN POINT		13.90	5.90	11.00	10.00	35.50	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73		24.77	19.10	21.90	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	13.90	19.80	30.80	40.80		74.30	78.30	82.30	86.30	90.30	94.30	98.30	102.30	106.03		130.80	149.90	171.80
KOT / ELEVATION	523.52	514.94	509.58	502.79	502.86		492.43	491.89	491.55	491.39	491.33	491.27	491.97	492.24	492.43		503.65	517.14	528.31
							SOL SU							SAĞ SU					


530
525
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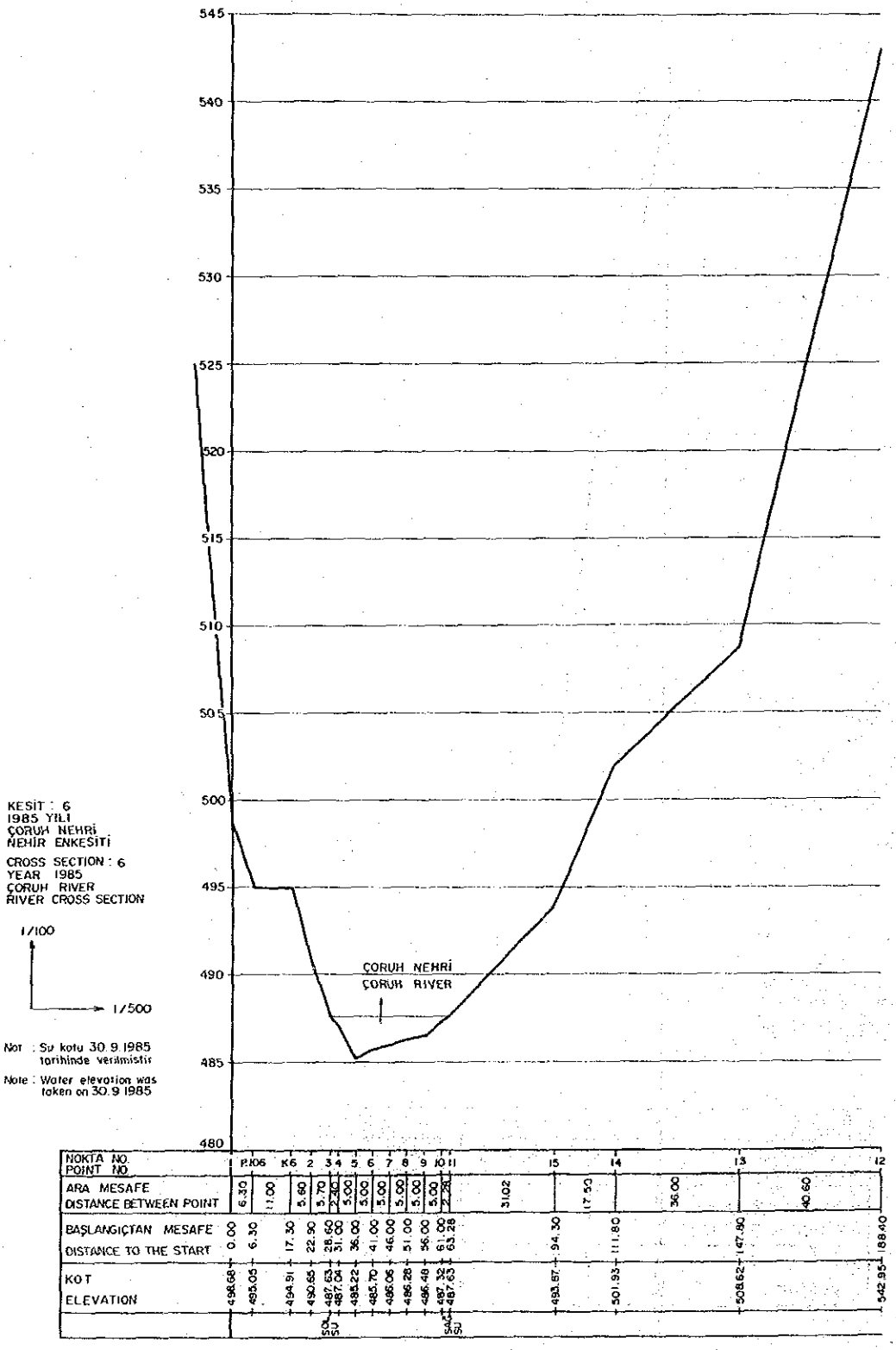
490
485
480
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 5
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 5
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. POINT NO.
1 2 3 P.105 K.5 4 5 6 7 8 9 10 11 12 13 14 15 16
ARA MESAFE DISTANCE BETWEEN POINT
11.14 6.80 7.14 10.97 11.86 8.57 4.27 5.00 5.00 5.00 5.00 5.00 5.00 5.00 4.50 20.75
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
0.00 11.14 17.94 25.08 35.05 47.91 56.48 60.75 65.75 70.75 75.75 80.75 85.75 90.75 95.75 100.75 105.25 126.00
KOT ELEVATION
528.03 516.94 509.58 497.13 497.20 490.64 489.98 490.08 489.55 489.17 489.23 489.15 488.92 489.01 489.09 489.33 490.08 495.38
SOL SU
SAĞ SU



KESİT : 6
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 6
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

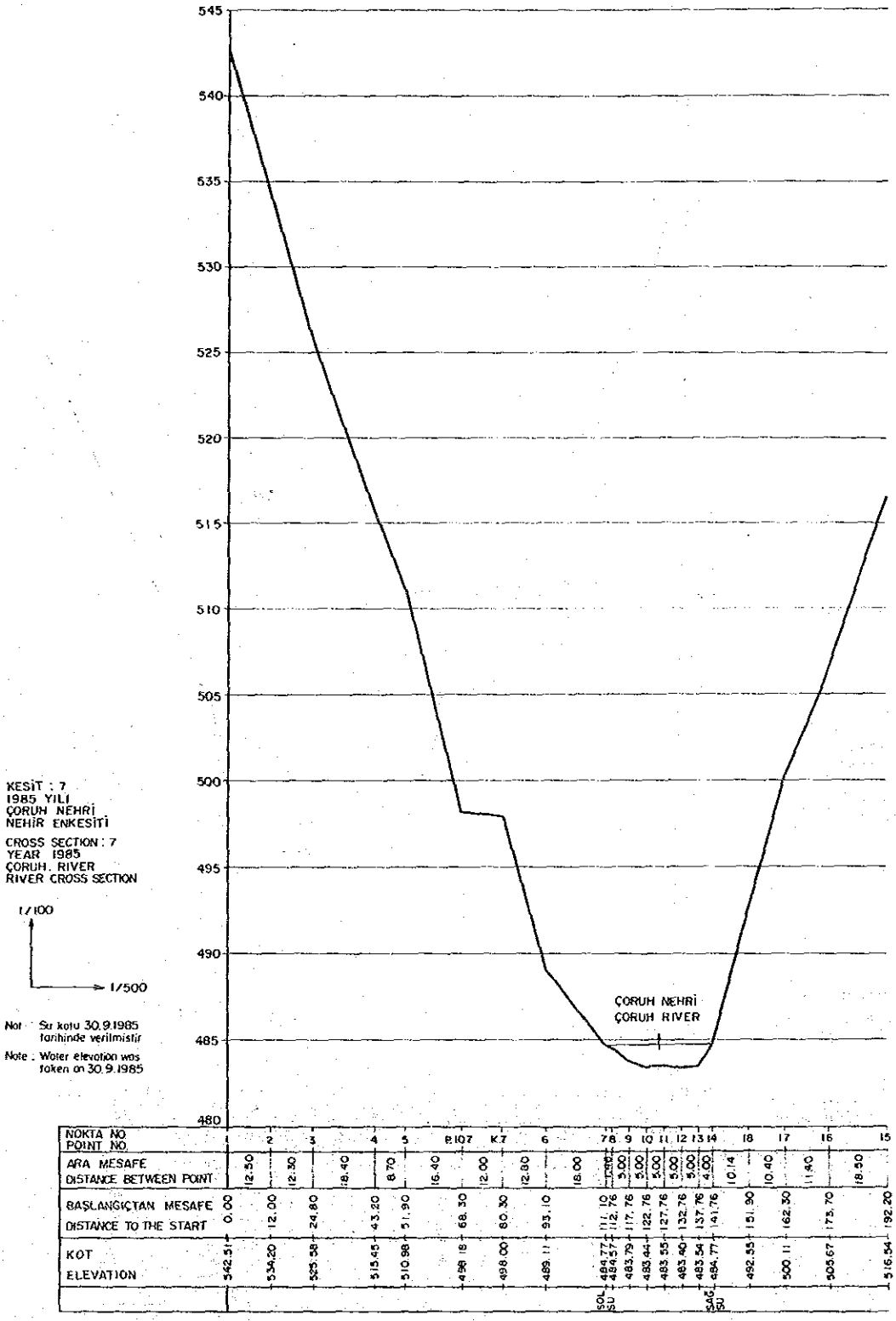
1/100

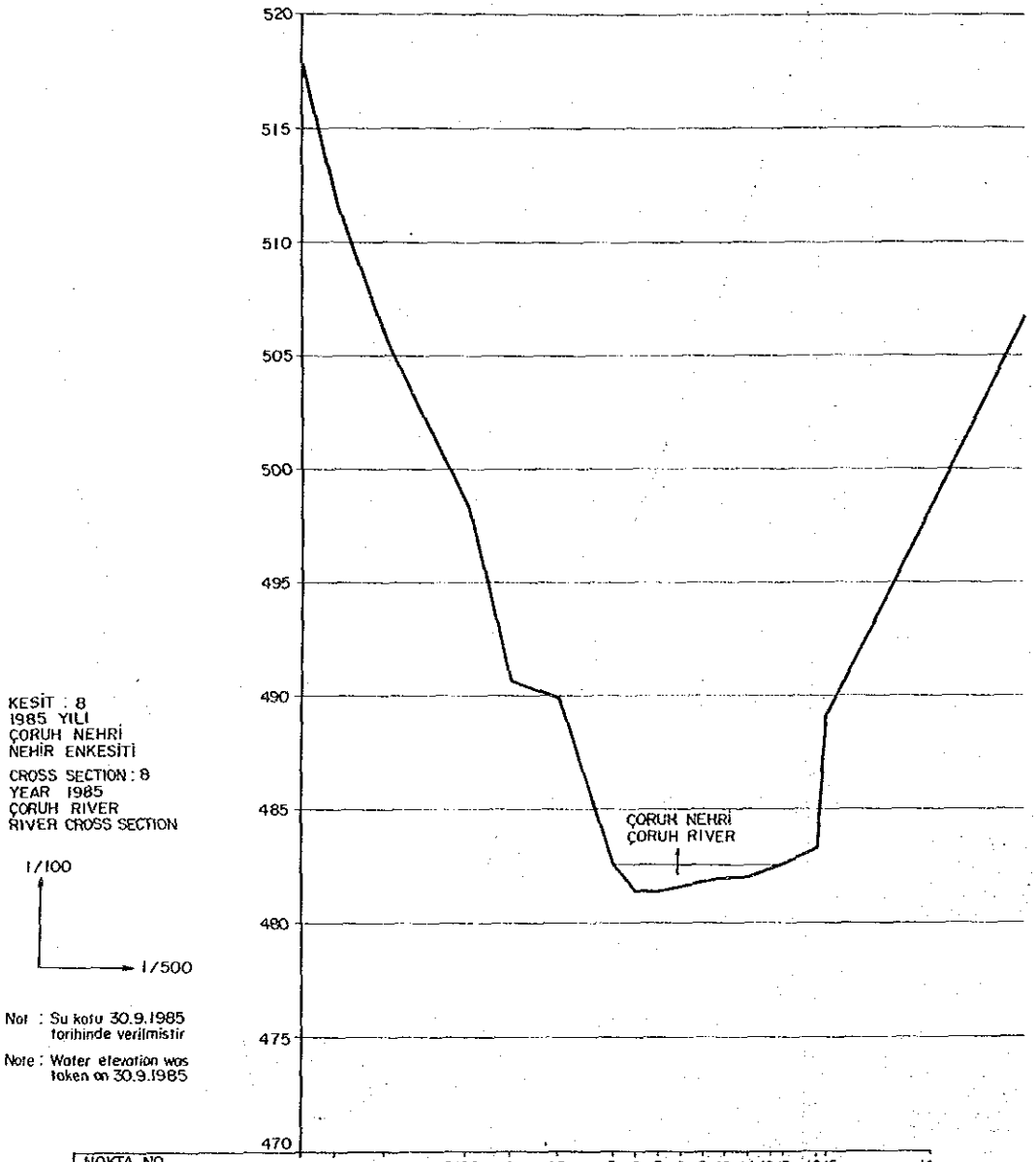
1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO / POINT NO	P.106	K6	2	3	4	5	6	7	8	9	10	11	15	14	13	12
ARA MESAFE / DISTANCE BETWEEN POINT	6.30	11.00	5.60	5.70	2.30	5.00	5.00	5.00	5.00	5.00	5.00	2.28	31.02	(17.50)	36.00	40.60
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	6.30	17.30	22.90	28.60	31.00	36.00	41.00	46.00	51.00	56.00	61.00	63.28	94.30	111.80	147.80	188.40
KOT / ELEVATION	498.68	495.05	494.91	490.65	487.53	487.04	485.22	485.70	486.06	486.28	486.48	487.32	487.63	493.67	501.93	508.62	542.95
					SU	SU						SU	SU				


545
540
535
530
525
520
515
510
505
500
495
490
485
480
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 7
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 7
YEAR 1985
ÇORUH. RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO
POINT NO.
ARA MESAFE
DISTANCE BETWEEN POINT
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
KOT
ELEVATION
SOL SU
SAĞ SU



KESİT : 8
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 8
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

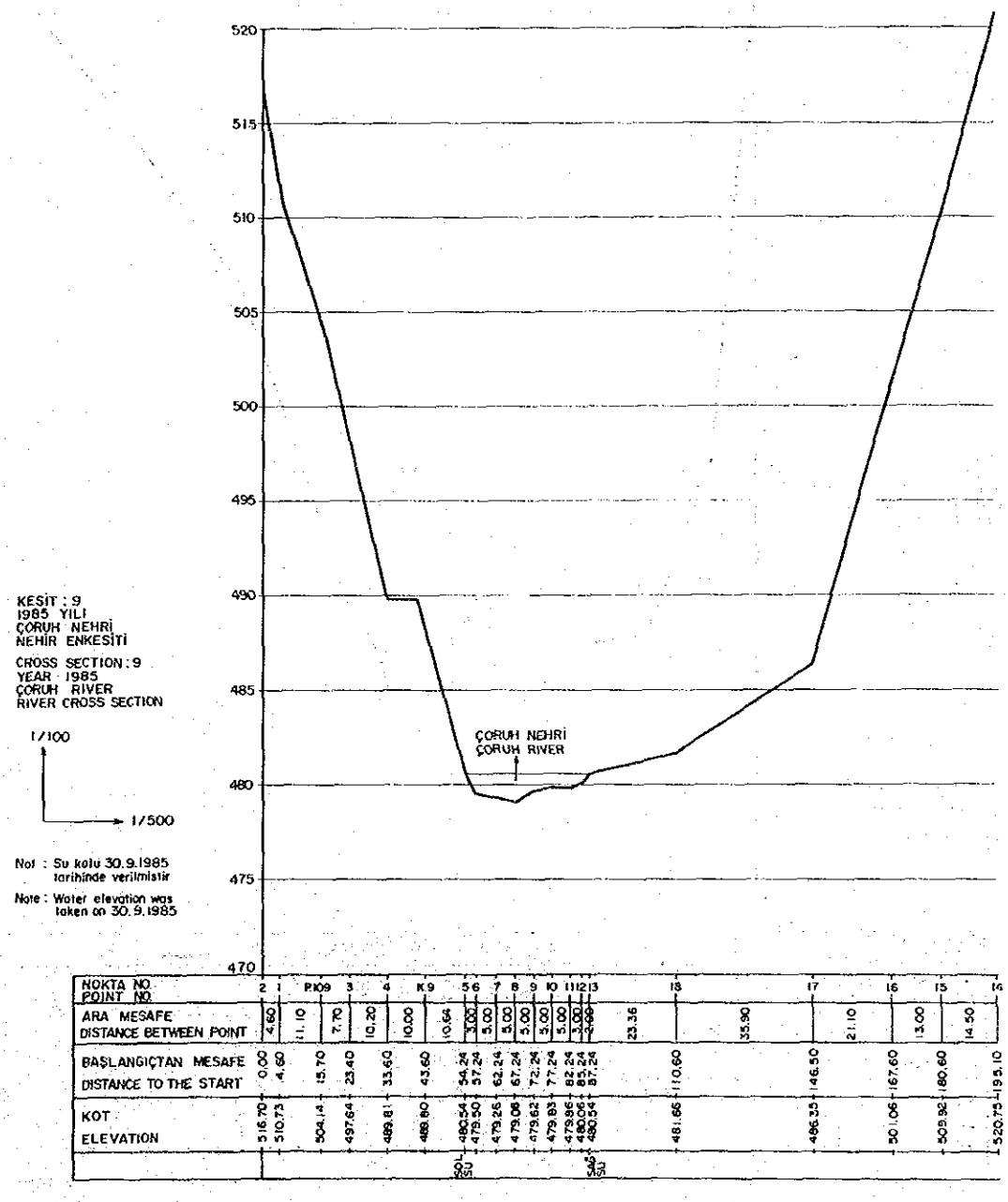
1/100

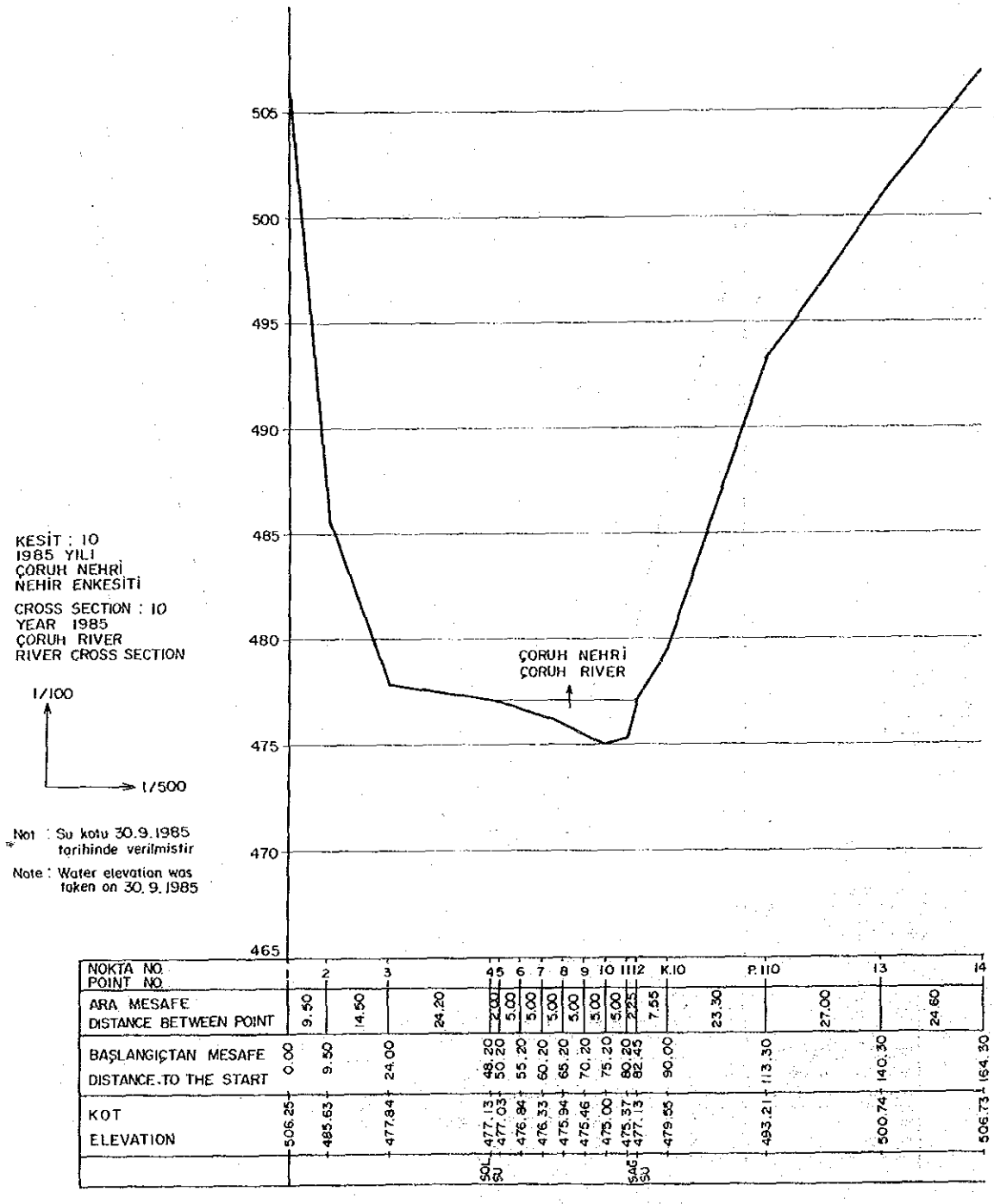
1/500

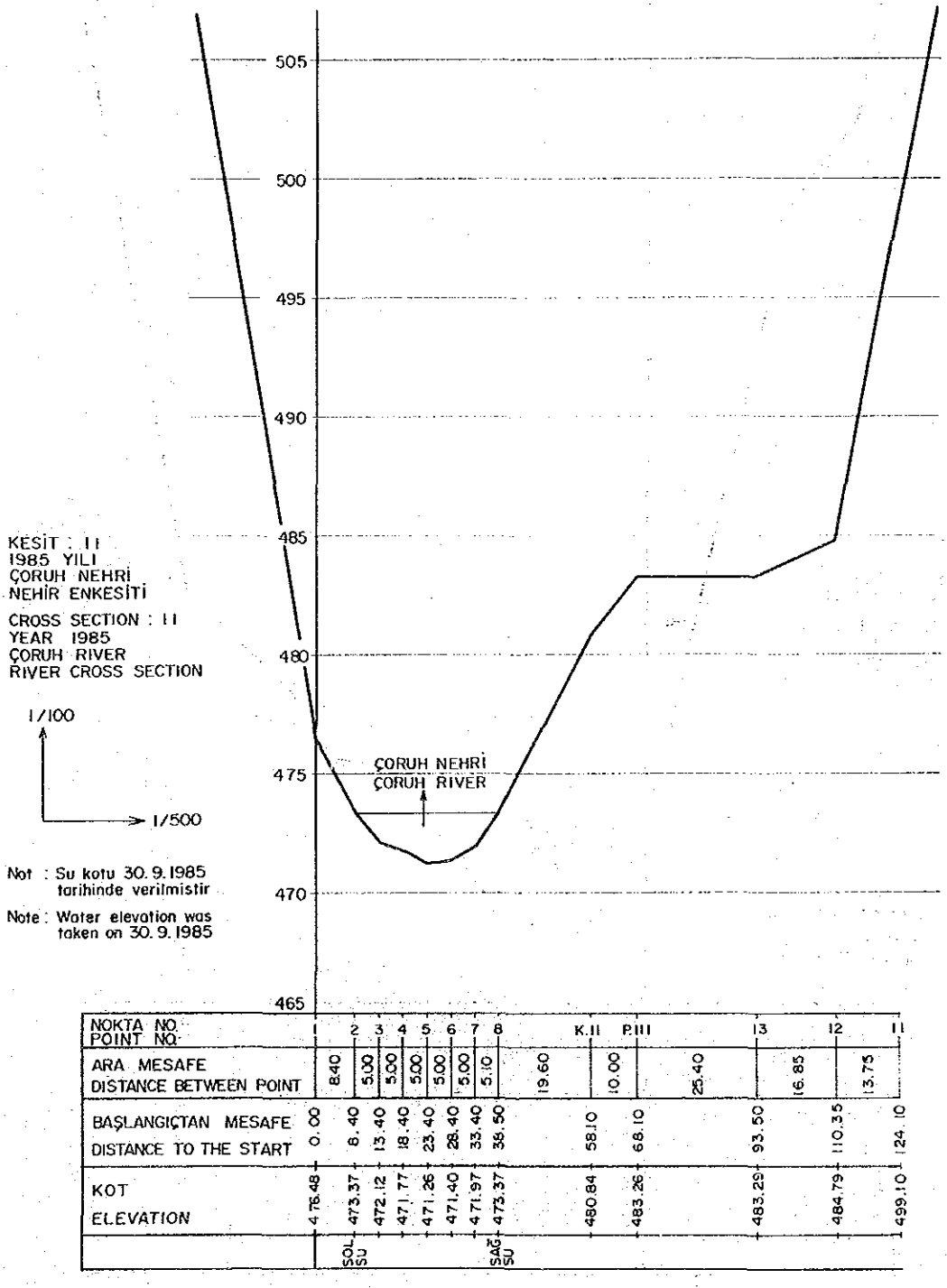
Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO. / POINT NO.		2	3	P.108	4	K.5	5	6	7	8	9	10	11	12	13	16	15	14
ARA MESAFE / DISTANCE BETWEEN POINT		7.80	10.90	18.20	9.80	11.00	12.10	5.00	5.00	5.00	5.00	5.00	5.00	5.00	2.67	7.33	1.90	23.20
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	7.80	18.70	36.90	46.70	57.70	69.80	74.80	79.80	84.80	89.80	94.80	99.80	104.80	107.47	114.80	116.70	139.90
KOT / ELEVATION	517.84	511.47	505.55	498.50	490.65	489.90	482.57	481.38	481.38	481.58	481.78	481.95	481.99	482.35	482.57	485.21	489.05	498.25
							SOL SU							SAĞ SU				


520
515
510
505
500
495
490
485
480
475
470
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 9
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 9
YEAR : 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. POINT NO.
2 1 P109 3 4 K9 5 6 7 8 9 10 11 12 13 18 17 16 15 14
ARA MESAFE DISTANCE BETWEEN POINT
4.60 11.10 7.70 10.20 10.00 10.64 3.00 5.00 5.00 5.00 5.00 3.00 3.00 23.36 35.90 21.10 13.00 14.50
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
0.00 4.60 15.70 23.40 33.60 43.60 54.24 57.24 62.24 67.24 72.24 77.24 82.24 85.24 87.24 110.60 146.50 167.60 180.60 195.10
KOT ELEVATION
516.70 510.73 504.14 497.64 489.81 488.80 480.54 479.50 479.26 479.08 479.62 479.83 479.86 480.06 480.54 481.65 486.33 501.06 508.92 520.73
SOL SU
SAĞ SU


KESİT : 10
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 10
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
505
500
495
490
485
480
475
470
465
ÇORUH NEHRİ
ÇORUH RIVER
NOKTA NO
POINT NO
1 2 3 4 5 6 7 8 9 10 11 12 K.10 P.110 13 14
ARA MESAFE
DISTANCE BETWEEN POINT
9.50 14.50 24.20 2.00 5.00 5.00 5.00 5.00 5.00 2.25 7.55 23.30 27.00 24.60
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 9.50 24.00 48.20 50.20 55.20 60.20 65.20 70.20 75.20 80.20 82.45 90.00 113.30 140.30 164.30
KOT
ELEVATION
506.25 485.63 477.84 477.13 477.03 476.84 476.33 475.94 475.46 475.00 475.37 477.13 479.55 493.21 500.74 506.73
SOL SU
SAĞ SU


505
500
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485
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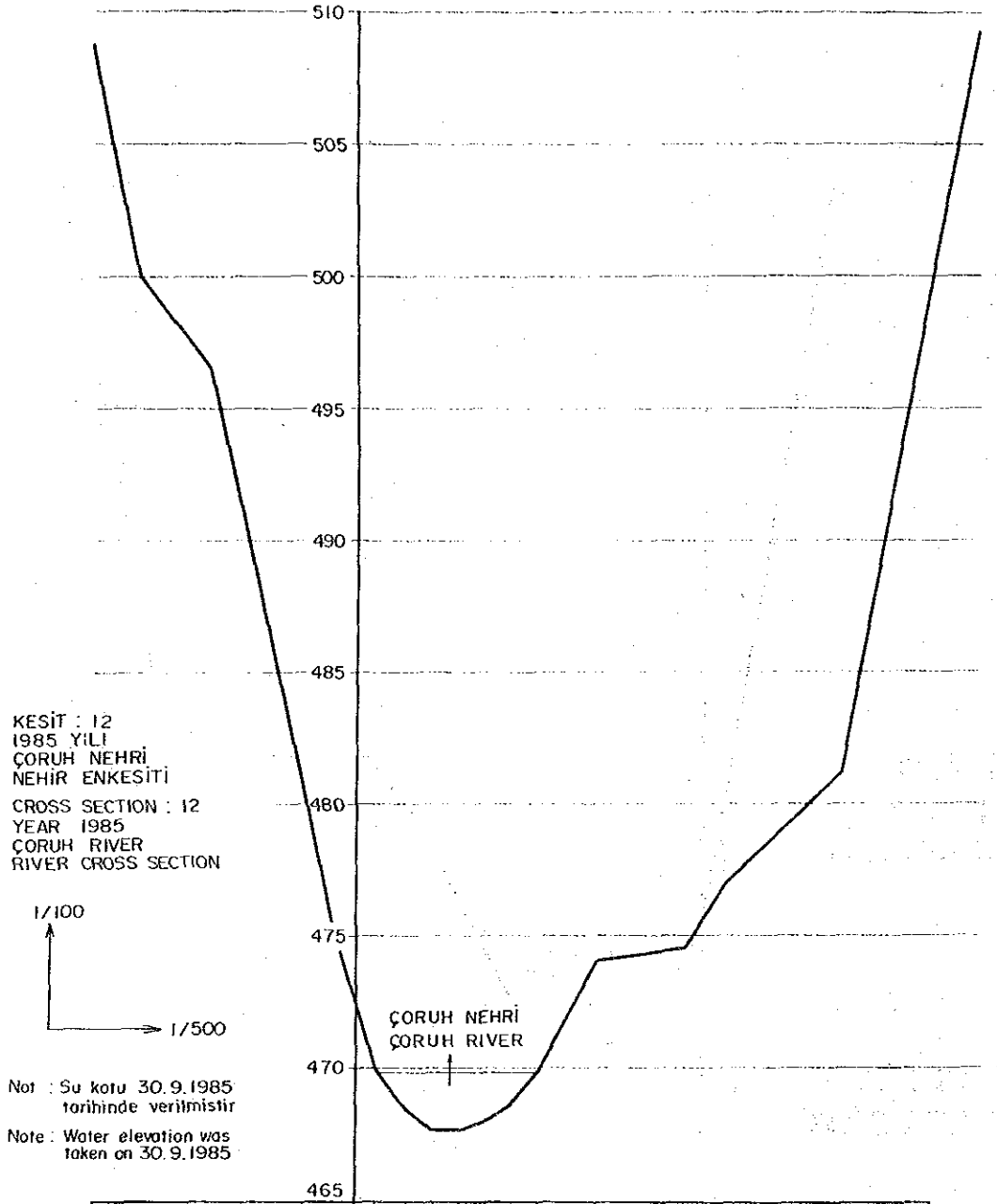
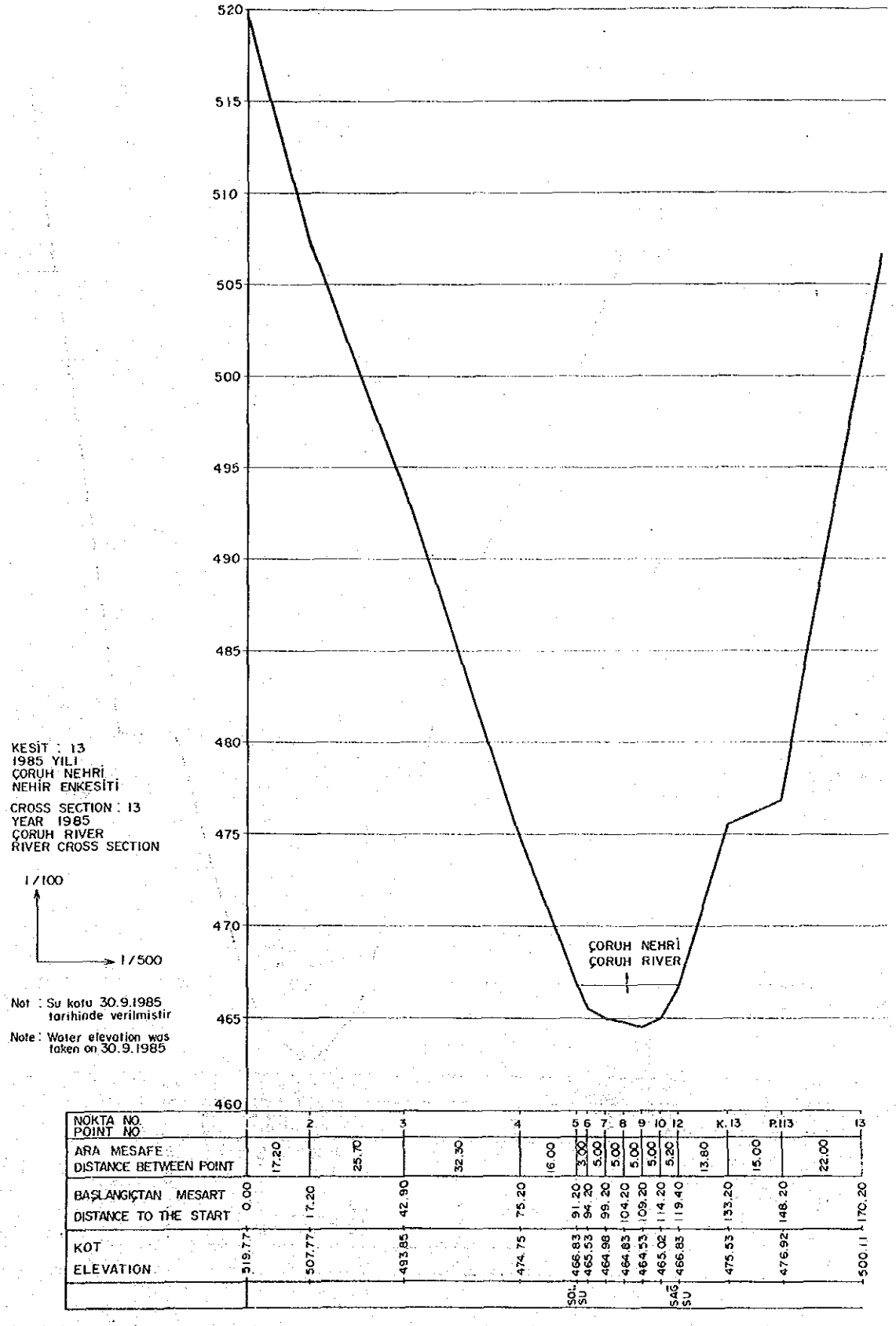
470
465
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : II
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : II
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO
POINT NO
1 2 3 4 5 6 7 8 K.II P.III 13 12 11
ARA MESAFE
DISTANCE BETWEEN POINT
8.40 5.00 5.00 5.00 5.00 5.00 5.10 19.60 10.00 25.40 16.85 13.75
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 8.40 13.40 18.40 23.40 28.40 33.40 38.50 58.10 68.10 93.50 110.35 124.10
KOT
ELEVATION
476.48 473.37 472.12 471.77 471.26 471.40 471.97 473.37 480.84 483.26 483.29 484.79 499.10
SOL SU
SAĞ SU



Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO. / POINT NO.	1	2	4	5	6	7	8	10	K12	P.112	13	12	11
ARA MESAFE / DISTANCE BETWEEN POINT		3.90	6.00	5.00	5.00	5.00	5.00	5.20	10.80	17.00	7.73	22.27	16.80
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	3.90	9.90	14.90	19.90	24.90	29.90	35.10	45.90	62.90	70.63	92.90	109.70
KOT / ELEVATION	472.53	469.84	468.39	467.60	467.57	467.98	468.63	469.84	474.03	474.51	476.99	481.26	499.61
		SOL SU					SAĞ SU						


520
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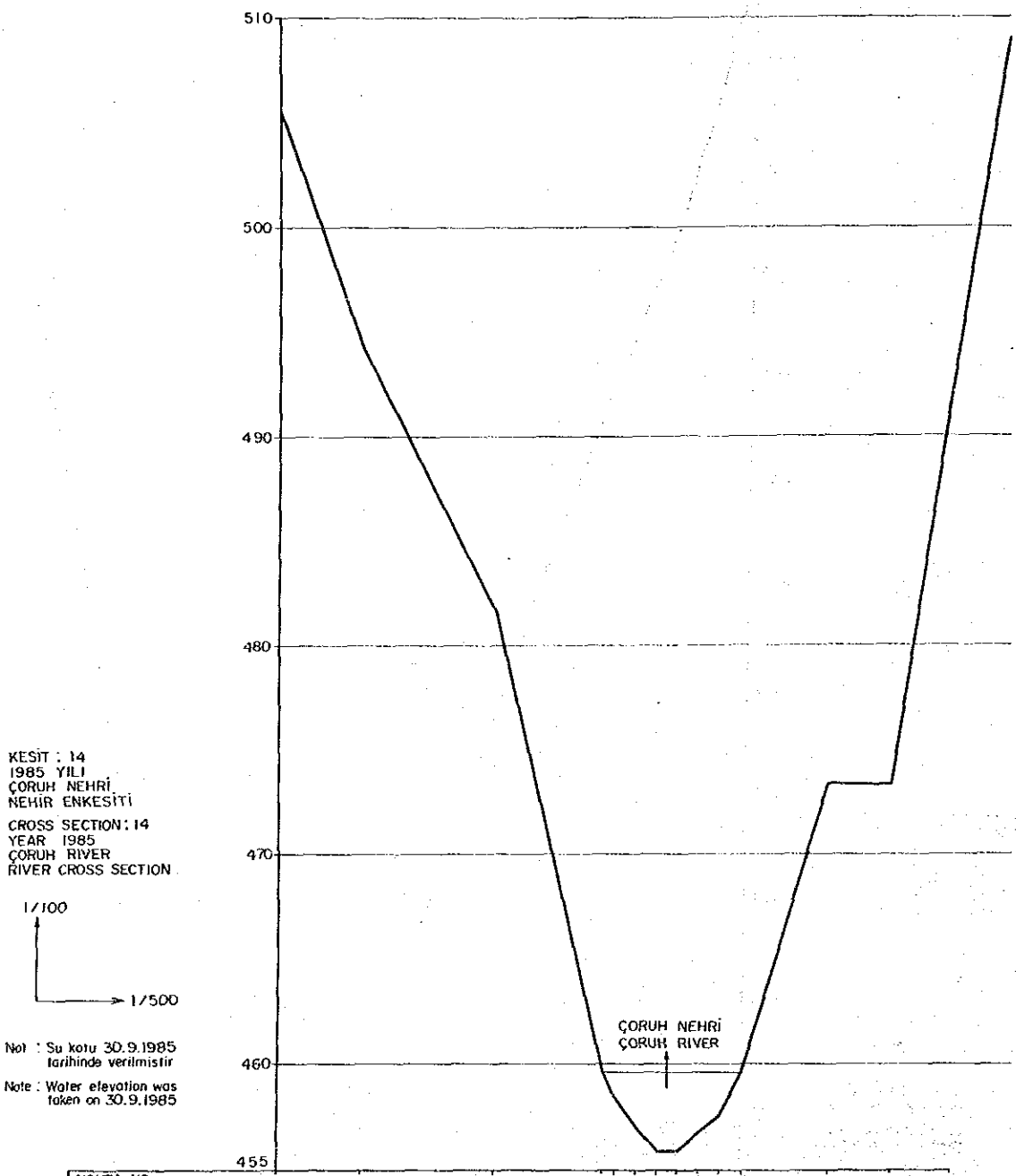
480
475
470
465
460
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 13
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 13
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. POINT NO
ARA MESAFE DISTANCE BETWEEN POINT
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
KOT ELEVATION
SOL SU
SAĞ SU



KESİT : 14
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION: 14
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

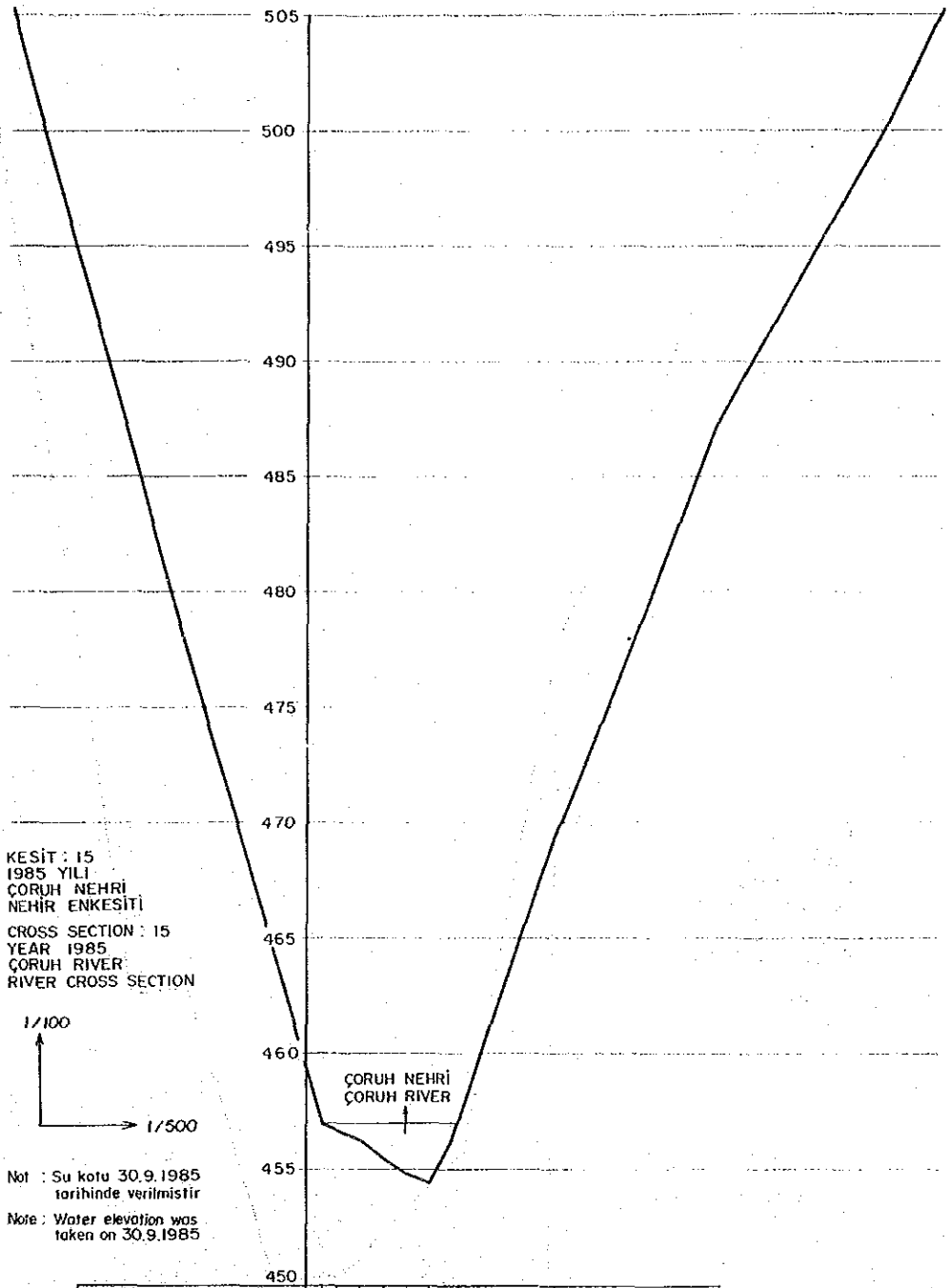
1/100

1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

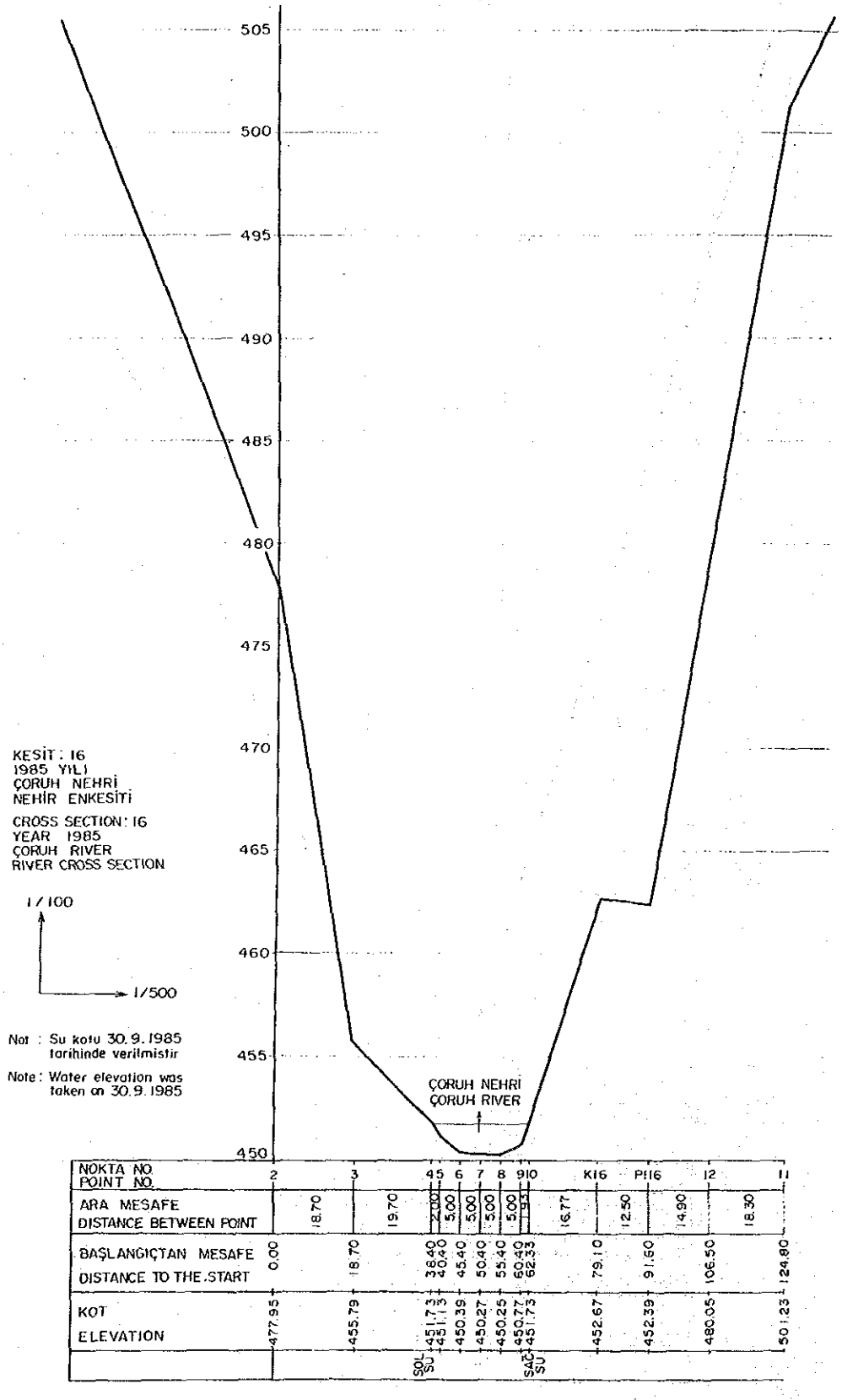
NOKTA NO. / POINT NO.	1	2	3	4	5	6	7	8	9	10	12	K.14	P.114	13
ARA MESAFE / DISTANCE BETWEEN POINT	20.00	31.90	26.10	3.00	5.00	5.00	5.00	5.00	5.00	5.30	20.80	15.00	14.51	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	20.00	51.90	78.00	81.00	86.00	91.00	96.00	101.00	106.00	111.30	132.10	147.10	161.61
KOT / ELEVATION	505.52	494.19	481.66	459.60	458.34	457.00	455.82	455.87	456.72	457.57	459.60	473.41	473.31	491.29
				SOL SU						SAĞ SU				



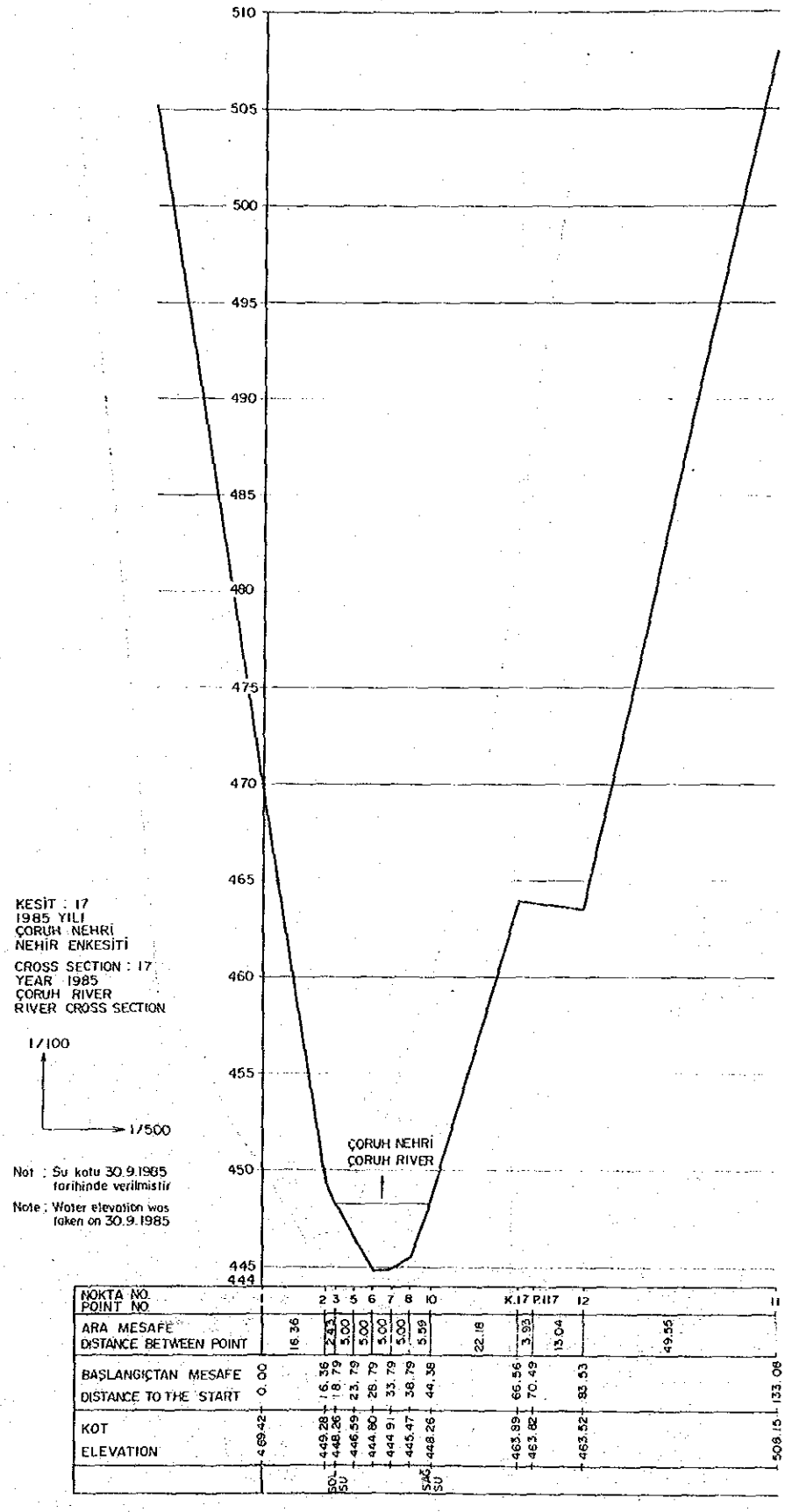
Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO. / POINT NO.	1	2	3	4	5	6	7	8	9	K15	P.115
ARA MESAFE / DISTANCE BETWEEN POINT		3.42	3.00	5.00	5.00	5.00	5.00	1.73	20.85	36.20	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	3.42	6.42	11.42	16.42	21.42	26.42	31.42 / 33.15		54.00	90.20
KOT / ELEVATION	459.41	456.97	453.89	456.29	455.48	454.78	454.41	456.16 / 456.97		469.28	487.46
		SOL SU						SAĞ SU			



NOKTA NO. POINT NO.	2	3	4	5	6	7	8	9	10	K16	P16	12	11
ARA MESAFE DISTANCE BETWEEN POINT	18.70	19.70	2.00	5.00	5.00	5.00	5.00	1.93	16.77	12.50	14.90	18.30	
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START	0.00	18.70	38.40	40.40	45.40	50.40	55.40	60.40	62.33	79.10	91.60	106.50	124.80
KOT ELEVATION	477.95	455.79	451.73	451.13	450.39	450.27	450.25	450.77	451.73	452.67	452.39	480.05	501.23
			SOL SU					SAĞ SU					


510
505
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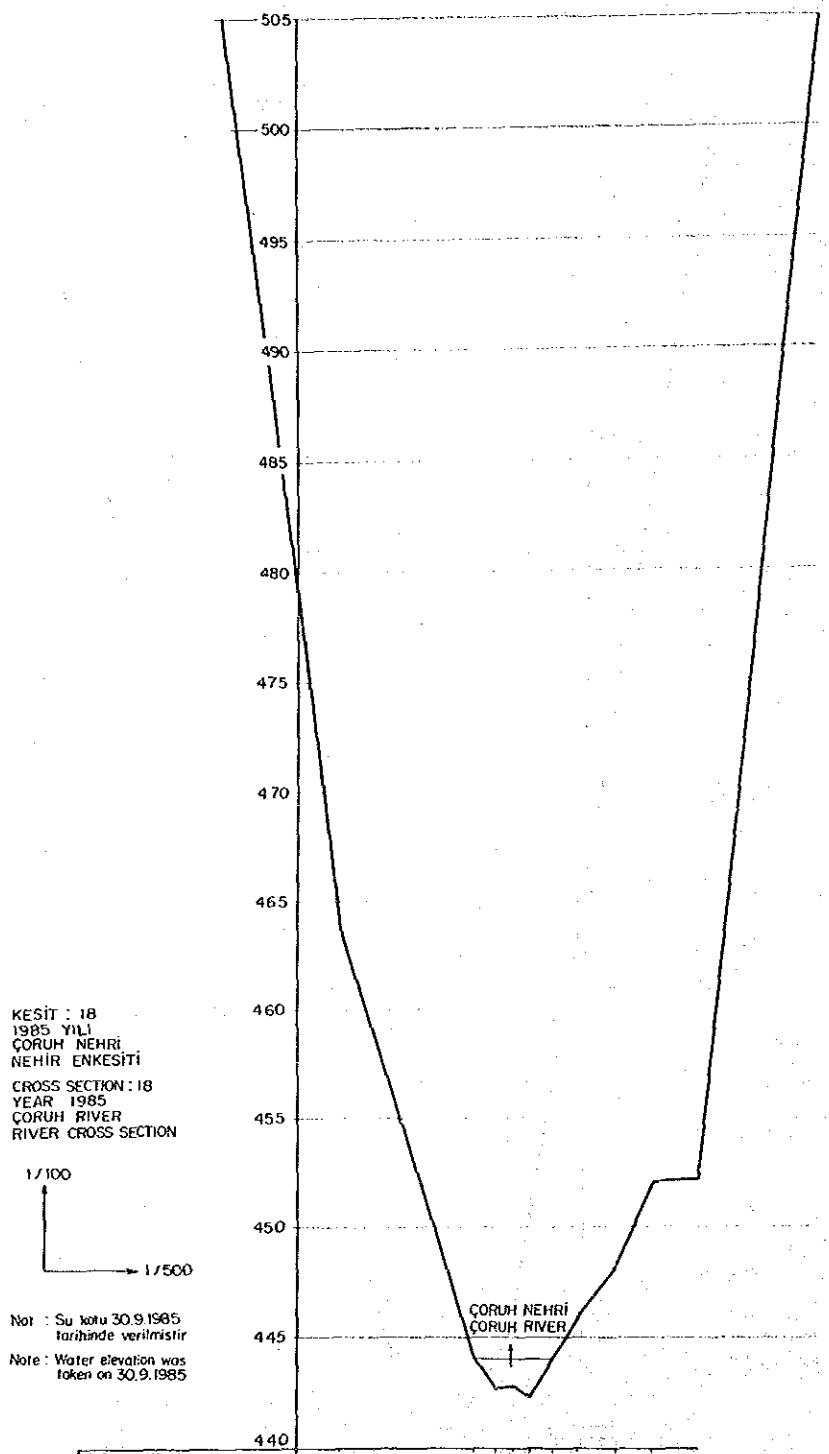
495
490
485
480
475
470
465
460
455
450
445
444
KESİT : 17
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 17
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
ÇORUH NEHRİ
ÇORUH RIVER
NOKTA NO
POINT NO
1 2 3 5 6 7 8 10 K.17 P.17 12 11
ARA MESAFE
DISTANCE BETWEEN POINT
16.36 2.43 5.00 5.00 5.00 5.00 5.59 22.18 3.93 13.04 49.55
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 16.36 18.79 23.79 28.79 33.79 38.79 44.38 66.56 70.49 83.53 133.08
KOT
ELEVATION
469.42 449.28 448.26 446.59 444.80 444.91 445.47 448.26 463.89 463.82 463.52 508.15
SOL SU
SAĞ SU



KESİT : 18
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 18
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

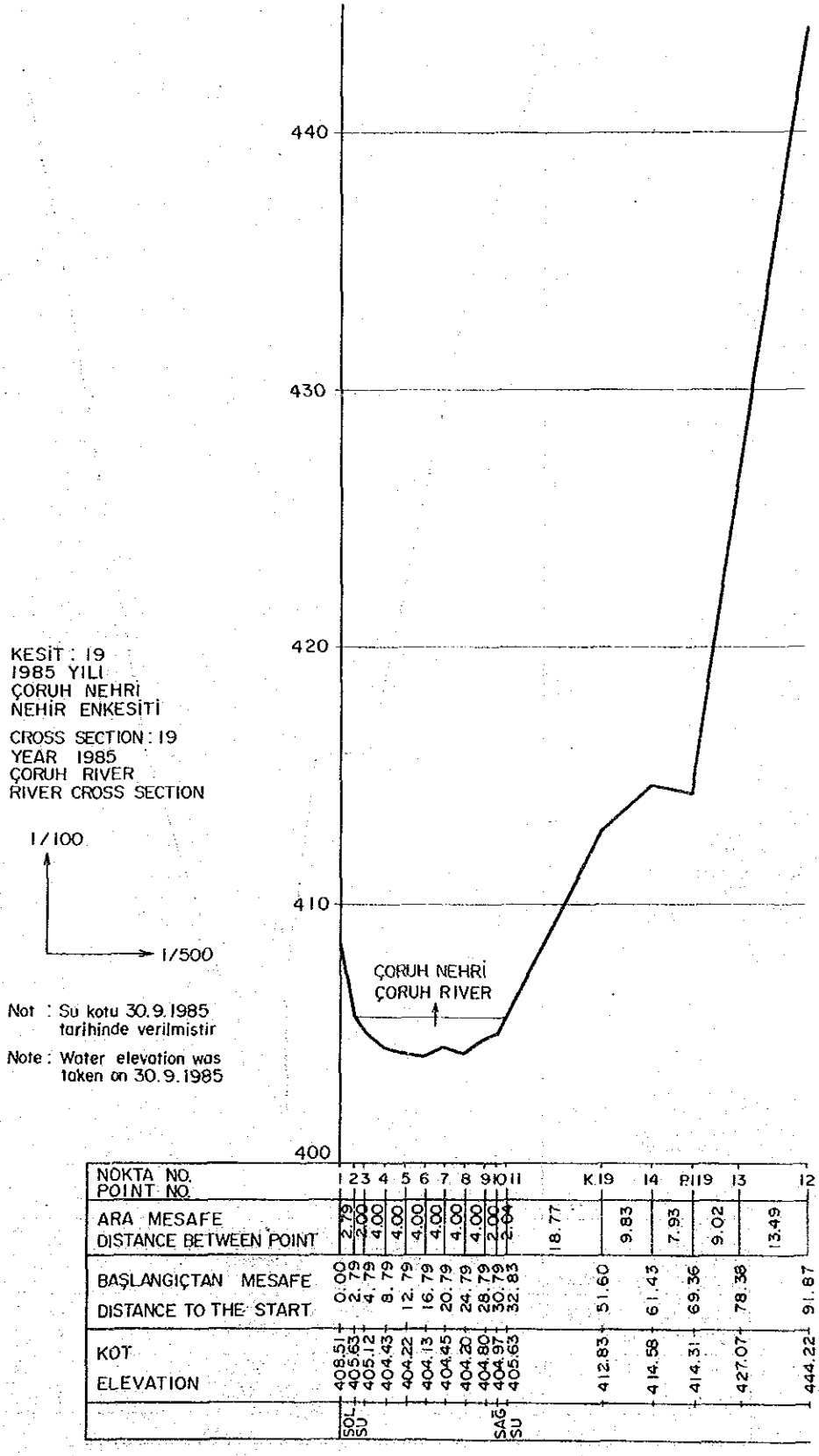
1/100

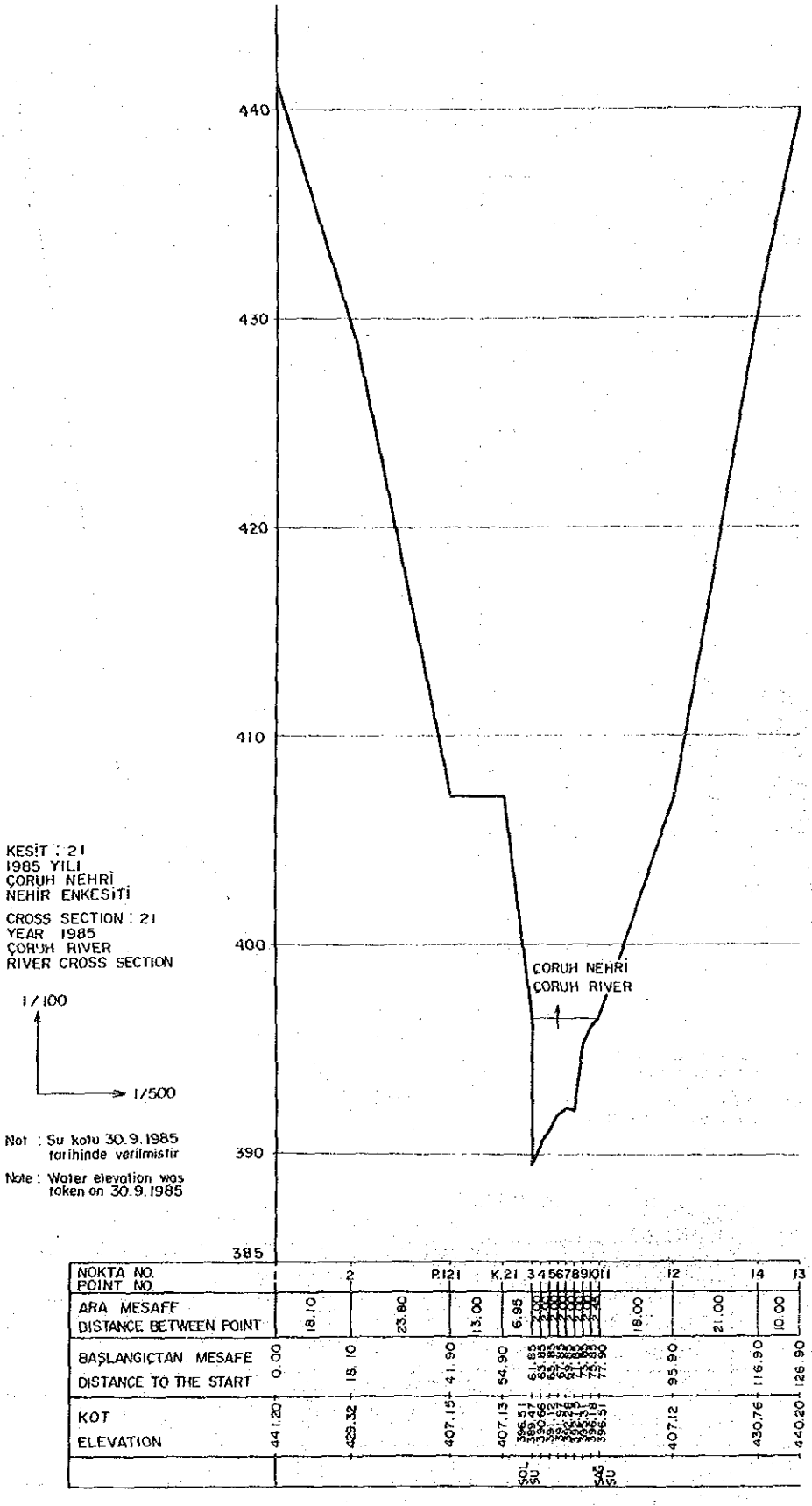
1/500

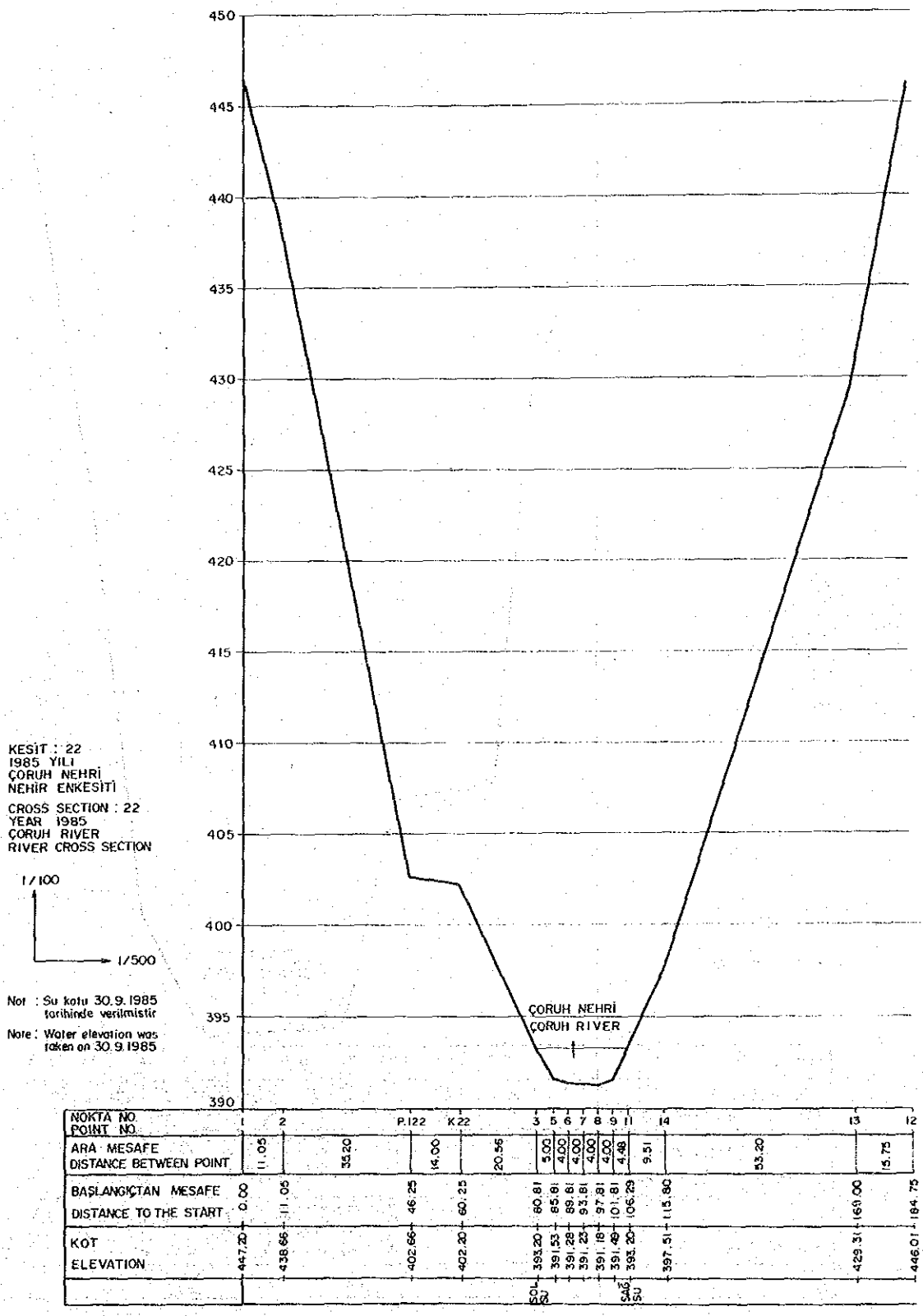
Not : Su kotu 30.9.1985 tarihinde verilmistir

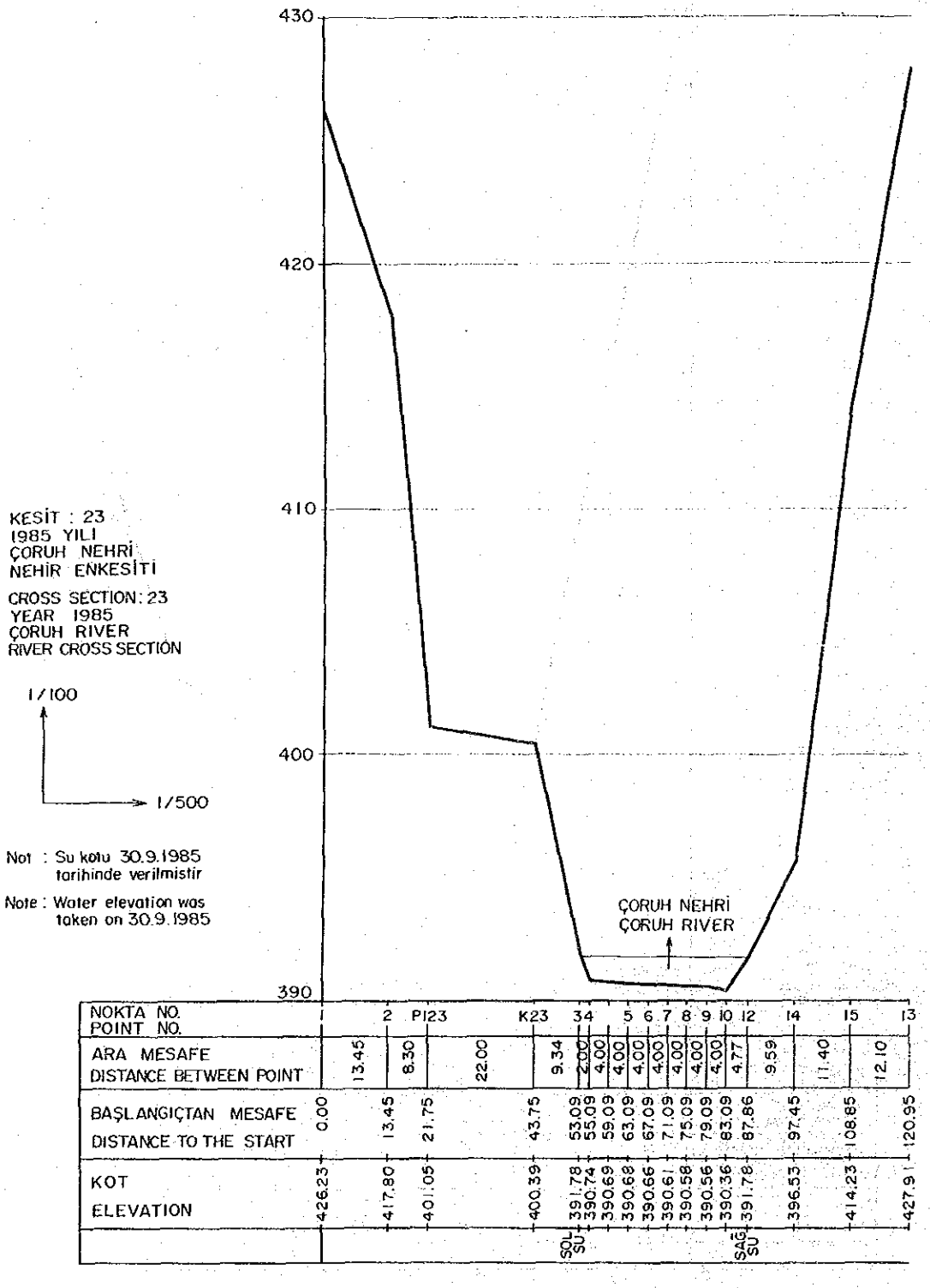
Note : Water elevation was taken on 30.9.1985

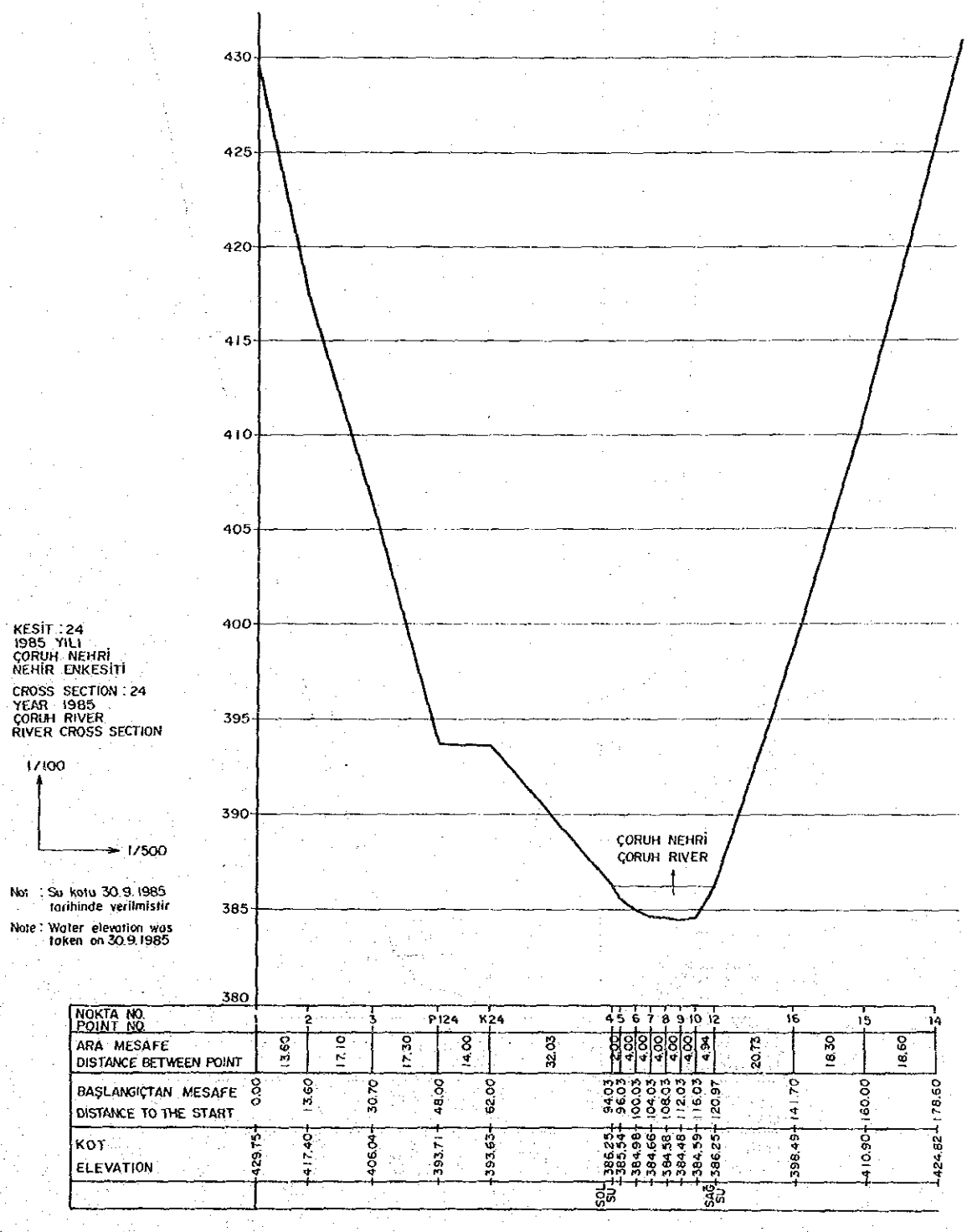
NOKTA NO. / POINT NO.	1	2	3	5	6	7	9	K18	ŞH8	10	11
ARA MESAFE / DISTANCE BETWEEN POINT	10.02	30.49	5.10	4.00	4.00	4.91	5.79	8.54	8.36	10.38	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00	10.02	40.51	45.61	49.61	53.61	58.52	64.31	72.85	81.21	91.59
KOT / ELEVATION	479.90	463.49	444.02	442.64	442.78	442.27	444.02	445.91	448.12	452.03	452.15
			SOL SU				SAĞ SU				

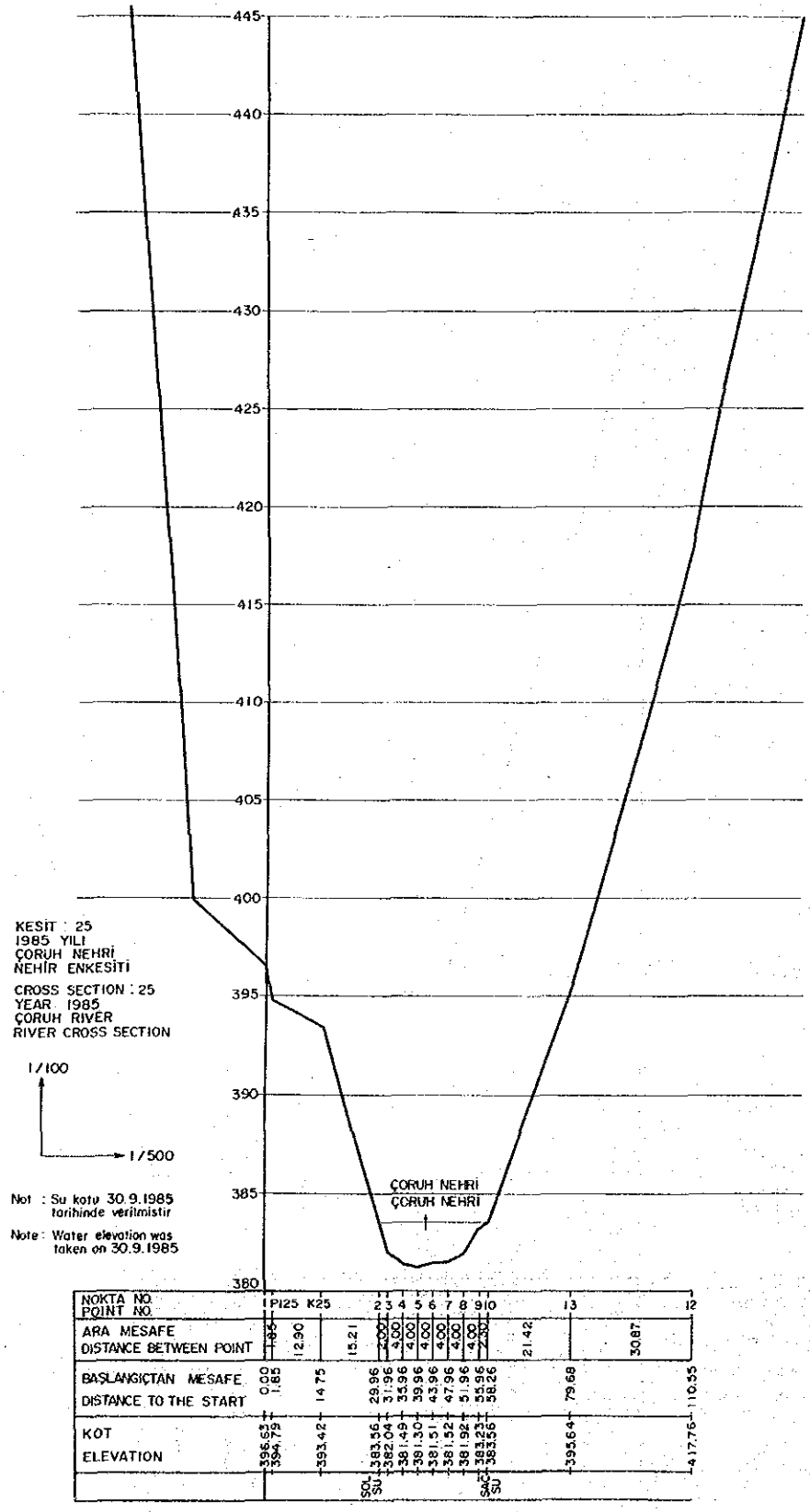

KESİT : 19
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 19
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
440
430
420
410
400
ÇORUH NEHRİ
ÇORUH RIVER
NOKTA NO. POINT NO. 1 2 3 4 5 6 7 8 9 10 11 K19 I4 P119 I3 12
ARA MESAFE DISTANCE BETWEEN POINT 2.79 2.00 4.00 4.00 4.00 4.00 4.00 2.00 2.04 18.77 9.83 7.93 9.02 13.49
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START 0.00 2.79 4.79 8.79 12.79 16.79 20.79 24.79 28.79 30.79 32.83 51.60 61.43 69.36 78.38 91.87
KOT ELEVATION 408.51 405.63 405.12 404.43 404.22 404.13 404.45 404.20 404.80 404.97 405.63 412.83 414.58 414.31 427.07 444.22
SOL SU
SAĞ SU

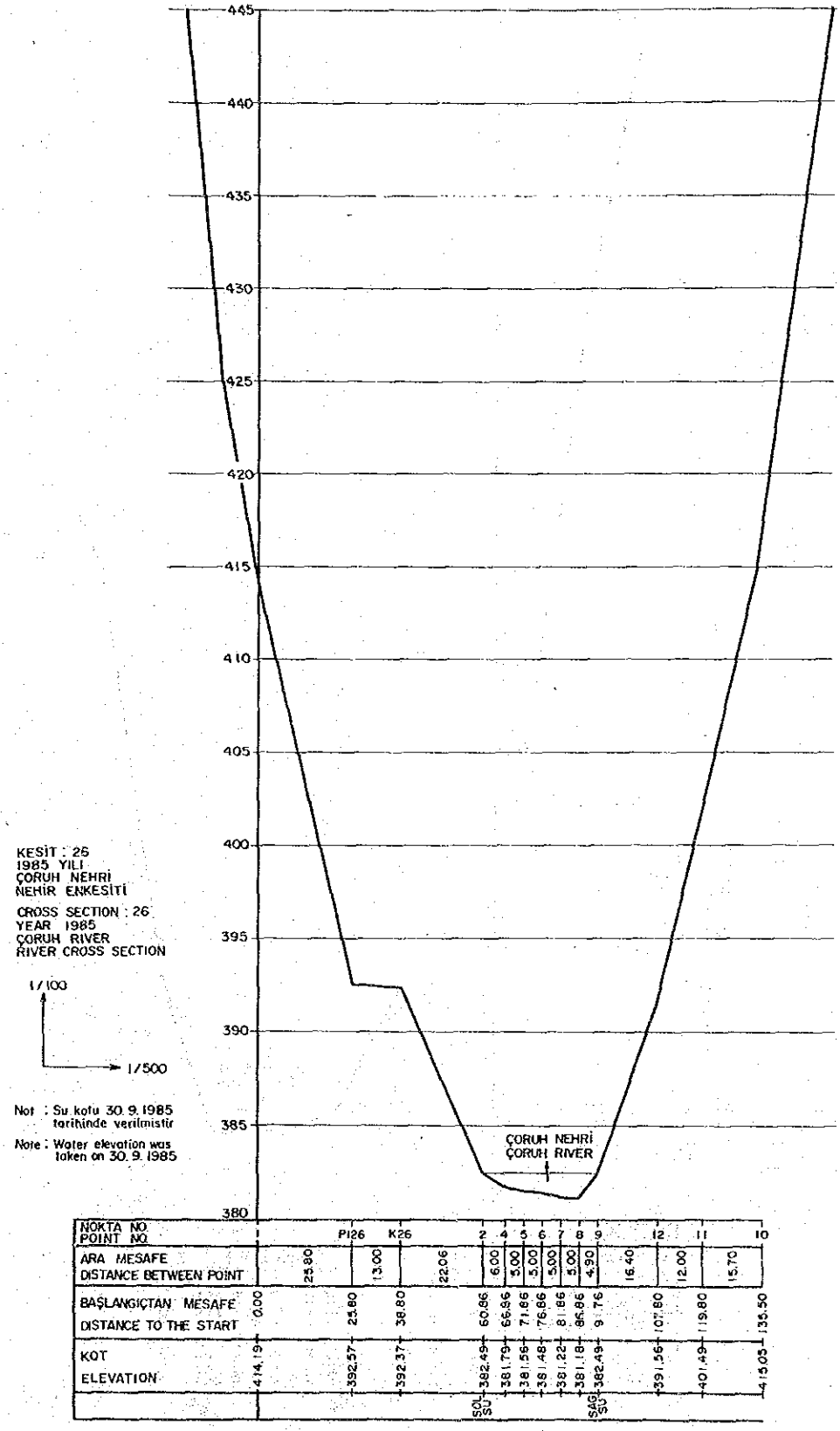

440
430
420
410
400
390
385
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 21
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 21
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. POINT NO.
ARA MESAFE DISTANCE BETWEEN POINT
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
KOT ELEVATION
SOL SU
SAĞ SU


450
445
440
435
430
425
420
415
410
405
400
395
390
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 22
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 22
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO
POINT NO
ARA MESAFE
DISTANCE BETWEEN POINT
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
KOT
ELEVATION
1 2 P.122 K22 3 5 6 7 8 9 11 14 13 12
11.05 35.20 14.00 20.56 5.00 4.00 4.00 4.00 4.00 4.48 9.51 53.20 15.75
0.0 11.05 46.25 60.25 80.81 85.81 89.81 93.81 97.81 101.81 106.29 115.80 169.00 184.75
447.20 438.66 402.66 402.20 393.20 391.53 391.28 391.23 391.18 391.49 393.20 397.51 429.31 446.01
SOL SU
SAĞ SU


430
420
410
400
390
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 23
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION: 23
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO. POINT NO.
1 2 P123 K23 34 5 6 7 8 9 10 12 14 15 13
ARA MESAFE DISTANCE BETWEEN POINT
13.45 8.30 22.00 9.34 2.00 4.00 4.00 4.00 4.00 4.00 4.00 4.77 9.59 11.40 12.10
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
0.00 13.45 21.75 43.75 53.09 55.09 59.09 63.09 67.09 71.09 75.09 79.09 83.09 87.86 97.45 108.85 120.95
KOT ELEVATION
426.23 417.80 401.05 400.39 391.78 390.74 390.69 390.68 390.66 390.61 390.58 390.56 390.36 391.78 396.53 414.23 427.91
SOL SU
SAĞ SU


KESİT : 24
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 24
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
430
425
420
415
410
405
400
395
390
385
380
ÇORUH NEHRİ
ÇORUH RIVER
NOKTA NO. / POINT NO.
1 2 3 P124 K24 4 5 6 7 8 9 10 12 16 15 14
ARA MESAFE / DISTANCE BETWEEN POINT
13.60 17.10 17.30 14.00 32.03 2.00 4.00 4.00 4.00 4.00 4.94 20.73 18.30 18.60
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START
0.00 13.60 30.70 48.00 62.00 94.03 96.03 100.03 104.03 108.03 112.03 116.03 120.97 141.70 160.00 178.60
KOT / ELEVATION
429.75 417.40 406.04 393.71 393.63 386.25 SOL SU 385.54 384.98 384.66 384.58 384.48 384.59 386.25 SAĞ SU 398.49 410.90 424.82


445
440
435
430
425
420
415
410
405
400
395
390
385
380
KESİT : 25
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 25
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
ÇORUH NEHRİ
ÇORUH NEHRİ
NOKTA NO
POINT NO
P125 K25 2 3 4 5 6 7 8 9 10 13 12
ARA MESAFE
DISTANCE BETWEEN POINT
1.85 12.90 15.21 2.00 4.00 4.00 4.00 4.00 4.00 2.30 21.42 30.87
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 1.85 14.75 29.96 31.96 35.96 39.96 43.96 47.96 51.96 55.96 58.26 79.68 110.55
KOT
ELEVATION
396.63 394.79 393.42 383.56 382.04 381.49 381.30 381.51 381.52 381.92 383.23 383.56 393.64 417.76
SOL SU
SAĞ SU


445
440
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395
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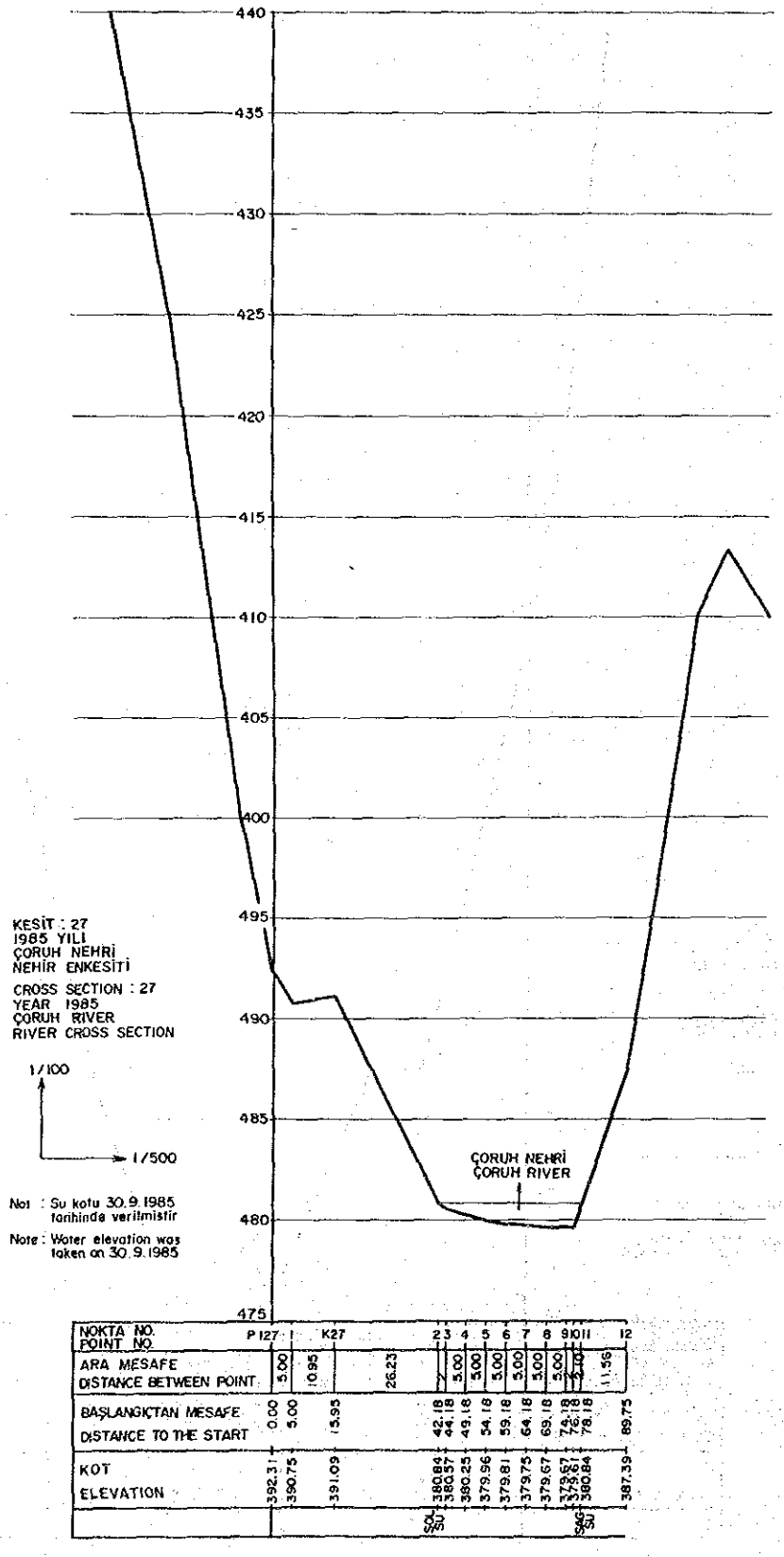
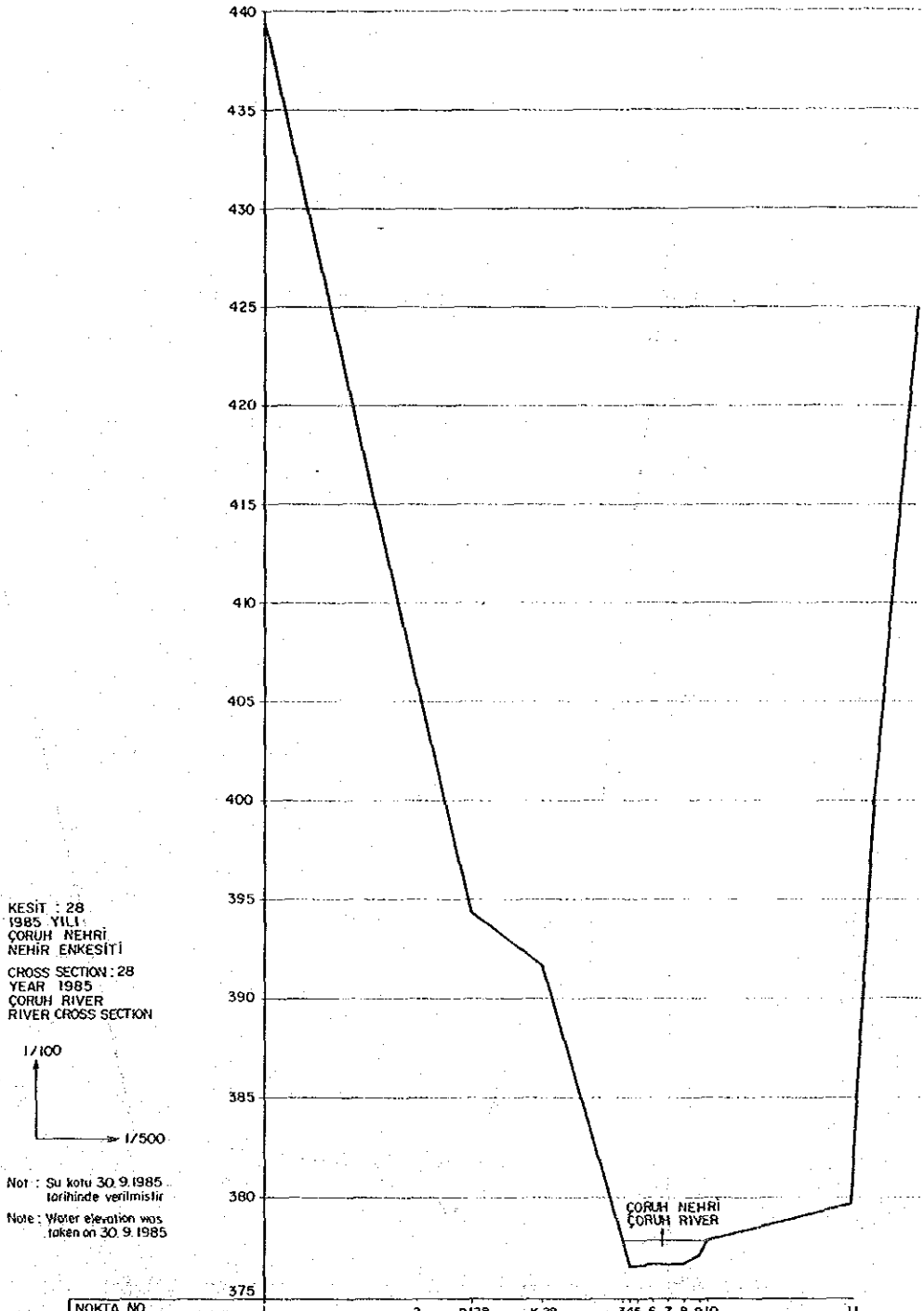
385
380
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 26
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 26
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
NOKTA NO
POINT NO
1 P126 K26 2 4 5 6 7 8 9 12 11 10
ARA MESAFE
DISTANCE BETWEEN POINT
25.80 13.00 22.06 6.00 5.00 5.00 5.00 5.00 4.90 16.40 12.00 15.70
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 25.80 38.80 60.86 66.86 71.86 76.86 81.86 85.86 90.76 107.80 119.80 135.50
KOT
ELEVATION
414.19 392.57 392.37 382.49 381.79 381.56 381.48 381.22 381.18 382.49 391.56 401.49 413.05
SOL SU
SAĞ SU


440
435
430
425
420
415
410
405
400
495
490
485
480
475
KESİT : 27
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 27
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30.9.1985
ÇORUH NEHRİ
ÇORUH RIVER
NOKTA NO. POINT NO
P 127
1
K27
2
3
4
5
6
7
8
9
10
11
12
ARA MESAFE DISTANCE BETWEEN POINT
5.00
10.95
26.23
2
5.00
5.00
5.00
5.00
5.00
2.10
11.56
BAŞLANGIÇTAN MESAFE DISTANCE TO THE START
0.00
5.00
15.95
42.18
44.18
49.18
54.18
59.18
64.18
69.18
74.18
76.28
78.18
89.75
KOT ELEVATION
392.31
390.75
391.09
380.84
380.57
380.25
379.96
379.81
379.75
379.67
379.67
379.60
380.84
387.39
SCA SU
SAĞ SU



KESİT : 28
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ

CROSS SECTION : 28
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION

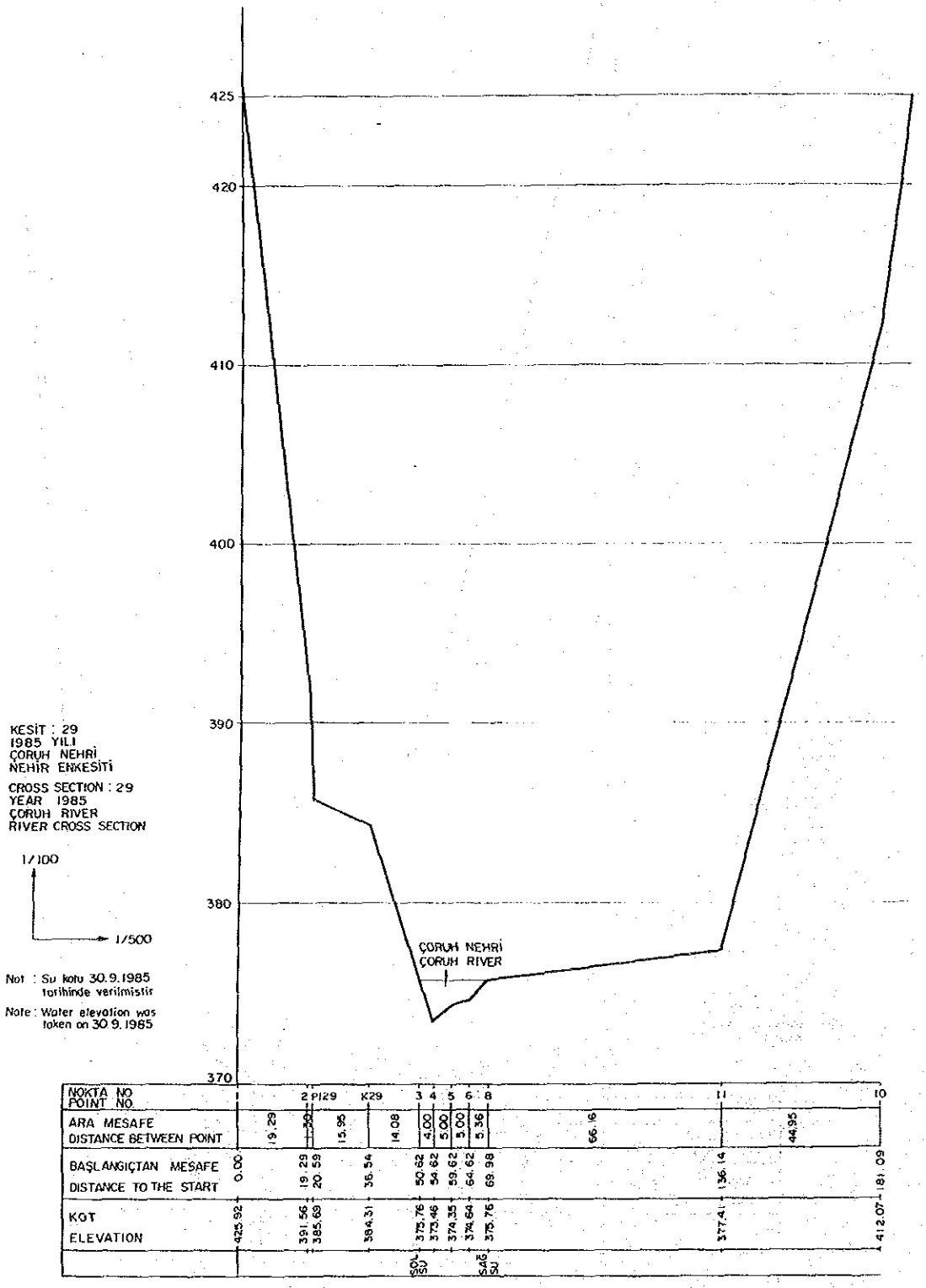
1/100

1/500

Not : Su kotu 30.9.1985 tarihinde verilmistir

Note : Water elevation was taken on 30.9.1985

NOKTA NO. / POINT NO.	1		2	P.128	K.28	3	4	5	6	7	8	9	10		11
ARA MESAFE / DISTANCE BETWEEN POINT		38.60		13.93	17.72	20.38	2.00	4.00	4.00	4.00	4.00	1.90		36.85	
BAŞLANGIÇTAN MESAFE / DISTANCE TO THE START	0.00		38.60	52.53	70.25		90.63	92.63	96.63	102.63	106.63	110.63	112.53		149.40
KOT / ELEVATION	439.68		406.21	394.35	391.71		377.92	376.60	376.64	376.71	376.70	376.73	377.14	377.92	379.69
							SOL SU						SAĞ SU		


425
420
410
400
390
380
370
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 29
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 29
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30.9.1985 tarihinde verilmistir
Note : Water elevation was taken on 30 9. 1985
NOKTA NO
POINT NO
1 2 PI29 K29 3 4 5 6 8 11 10
ARA MESAFE
DISTANCE BETWEEN POINT
19.29 1.30 15.95 14.08 4.00 5.00 5.00 5.36 66.16 44.95
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
0.00 19.29 20.59 36.54 50.62 54.62 59.62 64.62 69.98 136.14 181.09
KOT
ELEVATION
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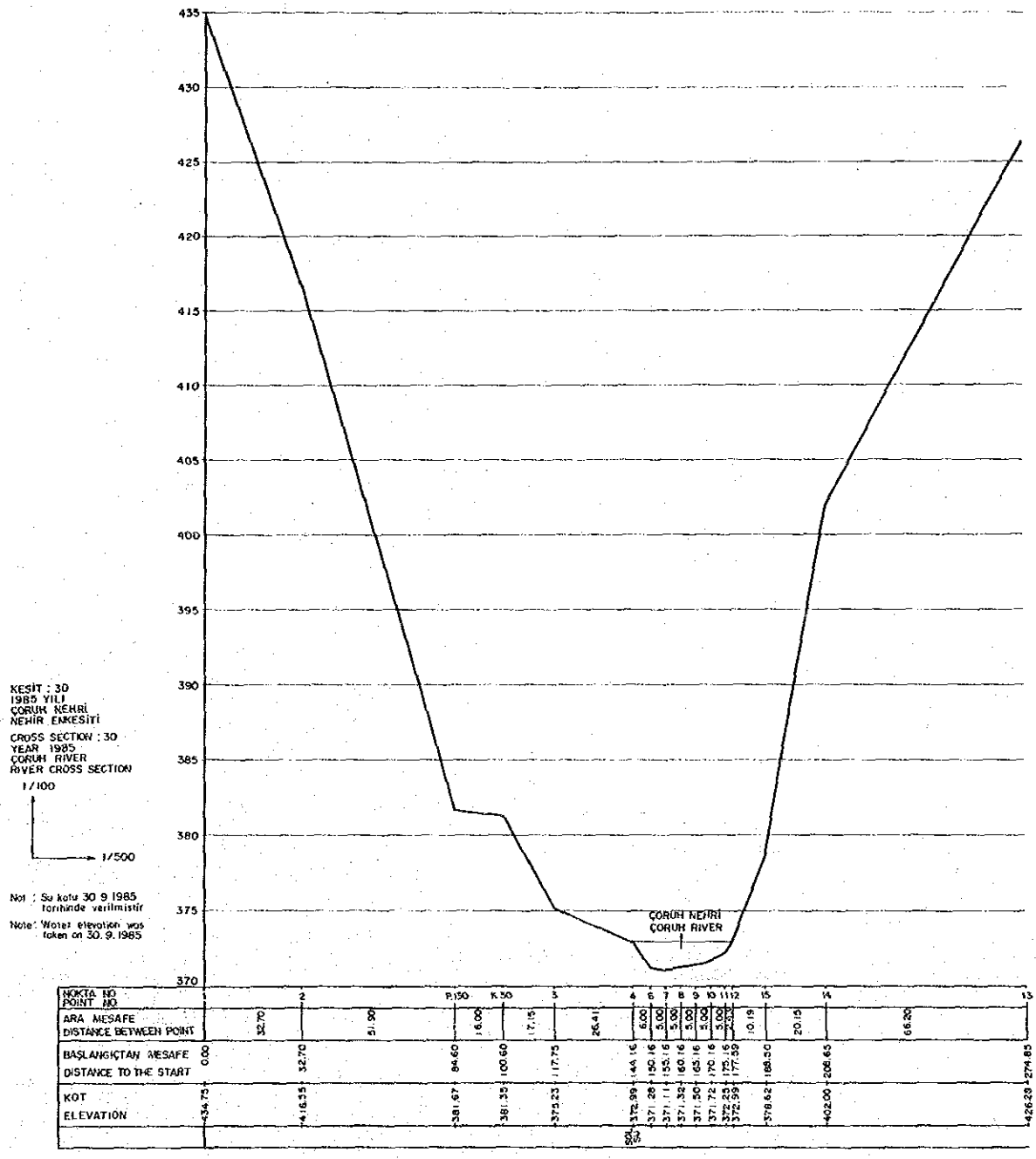
SOL SU
SAĞ SU


435
430
425
420
415
410
405
400
395
390
385
380
375
370
ÇORUH NEHRİ
ÇORUH RIVER
KESİT : 30
1985 YILI
ÇORUH NEHRİ
NEHİR ENKESİTİ
CROSS SECTION : 30
YEAR 1985
ÇORUH RIVER
RIVER CROSS SECTION
1/100
1/500
Not : Su kotu 30 9 1985 tarihinde verilmistir
Note: Water elevation was taken on 30. 9. 1985
NOKTA NO
POINT NO
ARA MESAFE
DISTANCE BETWEEN POINT
BAŞLANGIÇTAN MESAFE
DISTANCE TO THE START
KOT
ELEVATION
P.150
K.50
0.00
32.70
84.60
100.60
117.75
144.16
150.16
155.16
160.16
165.16
170.16
175.16
177.39
188.50
206.65
274.85
434.75
416.55
381.67
381.35
379.23
372.99
371.28
371.11
371.32
371.50
371.72
372.23
372.59
378.62
402.00
426.28

A－5 TRANSMISSION LINE PLAN

A–5 TRANSMISSION LINE PLAN

List of Table

A-5 TRANSMISSION LINE PLAN

Almost all power systems in Turkey are mutually interconnected to form a nation-wide grid. The feature of these interconnected systems is that the load centers are located in Ankara and in the western areas such as Istanbul, Izumir, etc., while a large part of the power supply capacity is located in the eastern region. The power consuming areas and the power generating areas are interconnected by long 380 kV transmission lines, which form the key transmission system connecting the east and west of Turkey.

As the distance between the power consuming areas and the power generating areas amount to about 1,000 km, it is expected that the power systems will face various technical problems as the electric demand increases in the future.

In planning power transmission for this Project which is situated in the northeastern region of Turkey, it would be required to conduct power system analysis studies, including the possibility of introducing a higher system voltage.

However, the power system analysis study related to this Project was excluded from the scope of the present study after consultation with the Government of Turkey held in February, 1986, because it was difficult at this stage to collect the data and information required for power system analysis. For this reason, a detailed power system analysis was not conducted relating to the present study.

However, a very general power transmission study was conducted based on the concept that the power output of this Project is transmitted to Ankara from Hopa Substation via Samsun thus assumed.

This transmission study was conducted with the objective of economic evaluations of this Project.

5.1 Transmission Line Plan from Hopa to Ankara

In Chapter 9-3 of this Main Report, it is assumed that the output of the Coruh Hydroelectric Power Development Project will be transmitted from Hopa to the load center of Ankara by means of the transmission facility which would be completed by the time of completion of the said project by TEK.

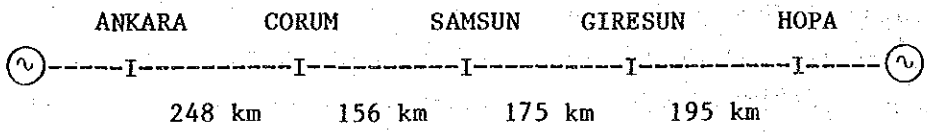
However, studies are performed here for a transmission line which is assumed to be constructed from Hopa to Ankara mainly form the point of view of power system stability, because the power system expansion program of TEK is not precisely known at this stage.

5.2 Condition of Study

(1) Transmission Line Voltage

The transmission line characteristics have been studied here for two cases: (1) All of the related power system is interconnected by 750 kV transmission line. (2) The section from Ankara to Samsun is interconnected by a 750 kV line, and the section from Samsun to Hopa is interconnected by a 380 kV line.

The power system models used in this study are illustrated below.



[CASE 1]

<---------- AC 750 kV ----------->

ACSR 954 MCM x 4 b., 1 cct.

[CASE 2]

<-------- AC 750 kV --------><-------- AC 380 kV -------->

ACSR 954 MCM x 4 b. ACSR 954 MCM x 2 b.

1 cct. 1 cct.

Transmission Line Impedance:

Case 1. Ankara -- Hopa; 2.38 + j37.8/750 kV

Case 2. Ankara -- Samsun; 1.24 + j19.7/750 kV
Interconnection transformer; j7.5
Samsun -- Hopa; 8.89 + j70.3/380 kV
Total; 10.13 + j97.5

The transmission line impedance of the following values were assumed.

750 kV: 0.003076 + j0.049 (%/km/1 cct., 1,000 MVA base)
380 kV: 0.02403 + j0.19 (%/km/1 cct., 1,000 MVA base)

The impedance of the interconnection transformer was assumed as 15% for its capacity, and the capacity was selected at 2,000 MVA.

(2) Generator Capacities

Coruh Project side; 1,000 MW hydroelectric power
Ankara side; infinite bus

(3) Load Conditions

It was assumed that the whole power is to be transmitted to Ankara, and the intermediate loads were neglected.

5.3 Result of Study

(1) Selection of Transmission Voltage

In the two study cases selected in Section 2. (1), the phase angle differences between the power plant bus and Ankara were as described below.

[Case 1] $P = 1.0 = (1 \times 1/0.378) \sin\theta$

$\theta = 22.2$ degrees

[Case 2] $P = 1.0 = (1 \times 1/0.975) \sin\theta$

$\theta = 90$ degrees

Thus the phase angle difference in Case 2 indicates that the condition is at the transmission capacity limit, and it is necessary to interconnect the whole distance with a 750 kV transmission line.

(2) Transmission Capacity Limit

The characteristics of the transmission line was studied for the case that power other than from Yusufeli and Artvin were superimposed on the transmission line, to find out the status when the line power flow is increased over the output of the two Projects.

As the planned transmission line has only one circuit, the assumed fault condition has to be an one-line-to-ground fault. Although more detailed data are required for rigorous studies, the results of roughly study based only on the available data indicated that the transmission capacity limit is approximately 1,500 MW.

5.4 Construction Schedule and Cost Estimation

(1) Construction Schedule

A period of 42 months was assumed to be required for construction of a transmission line (750 kV, single circuit) from Hopa to Ankara which is 780 km long.

(2) Cost Estimation

* The construction cost of the transmission line was calculated based on the unit construction cost, which was proposed by EIE through TEK.

* Concerning electrical equipments, the switch gear sets and the outgoing lines for the Hopa Substation outgoing circuit and the Ankara Substation incoming circuits were counted in the construction cost.

* The state tax is calculated as 10% of the material and equipment costs.

* The project controlling cost is calculated as 15% of each transmission and electrical equipment construction cost including the installation cost.

* The construction costs to be paid by the domestic currency and the foreign currency are presented in Table AP.5-1 and Table AP.5-2 respectively.

The transmission capacity limit of this transmission line is assumed as 1,500 MW as discussed in the preceding section. The cost of the transmission line was allocated to Yusufeli Project (540 MW), Artvin Project (320 MW) and other projects which use this transmission capacity in proportion to the amount of power.

The construction costs to be paid by the domestic currency and the foreign currency are presented in Table AP.5-3 through Table AP.5-6.

Table AP.5–1 Estimated Construction Cost
(for 1,500 MW Capacity)

(10^6 T.L.)

Description	D.C.	F.C.	Total
Financial Cost			
(I) with Tax			
Transmission Line	18,876	41,184	60,060
Electrical Equipment	154	1,120	1,274
Project Controlling	6,439	2,761	9,200
Sub Total	25,469	45,065	70,534
Interest during Construction Period	6,380	13,835	20,215
Grand Total	31,849	58,900	90,749
(II) without Tax			
Transmission Line	14,757	41,184	55,941
Electrical Equipment	140	1,120	1,260
Project Controlling	6,439	2,761	9,200
Grand Total	21,336	45,065	66,401

Table AP.5–2 Fund Requirement in Each Year (for 1,500 MW Capacity)

(10^6 T.L.)

Description	1st Year (5th)		2nd Year (6th)		3rd Year (7th)		4th Year (8th)		5th Year (9th)		Total	
	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.
Financial Cost												
(I) with Tax												
Transmission Line	824	8,237	4,971	20,180	6,767	8,649	6,314	4,118	–	–	18,876	41,184
Electrical Equipment	–	–	–	–	0	112	154	1,008	–	–	154	1,120
Project Controlling	951	408	2,641	1,132	1,630	699	1,217	522	–	–	6,439	2,761
Sub Total	1,775	8,645	7,612	21,312	8,397	9,460	7,685	5,648	–	–	25,469	45,065
Interest during Construction Period	84	411	530	1,834	1,291	3,296	2,055	4,013	2,420	4,281	6,380	13,835
Grand Total	1,859	9,056	8,142	23,146	9,688	12,756	9,740	9,661	2,420	4,281	31,849	58,900
(II) without Tax												
Transmission Line	0	8,237	2,953	20,180	5,902	8,649	5,902	4,118	–	–	14,757	41,184
Electrical Equipment	–	–	–	–	0	112	140	1,008	–	–	140	1,120
Project Controlling	951	408	2,641	1,132	1,630	699	1,217	522	–	–	6,439	2,761
Grand Total	951	8,645	5,594	21,312	7,532	9,460	7,259	5,648			21,336	45,065

Table AP.5–3 Estimated Construction Cost
(for Yusufeli Project)

(10^6 T.L.)

Description	D.C.	F.C.	Total
Financial Cost			
(I) with Tax			
Transmission Line	6,796	14,826	21,622
Electrical Equipment	55	403	458
Project Controlling	2,318	995	3,313
Sub Total	9,169	16,224	25,393
Interest during Construction Period	2,297	4,981	7,278
Grand Total	11,466	21,205	32,671
(II) without Tax			
Transmission Line	5,313	14,826	20,139
Electrical Equipment	50	403	453
Project Controlling	2,318	995	3,313
Grand Total	7,681	16,224	23,905
Economic Cost			
Transmission Line	3,603	14,826	18,429
Electrical Equipment	38	403	441
Project Controlling	1,831	995	2,826
Grand Total	5,472	16,224	21,696

Table AP.5–4 Fund Requirement in Each Year (for Yusufeli Project)

(10^6 T.L.)

Description	1st Year (5th)		2nd Year (6th)		3rd Year (7th)		4th Year (8th)		5th Year (9th)		Total	
	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.
Financial Cost												
(I) with Tax												
Transmission Line	297	2,965	1,790	7,265	2,436	3,114	2,273	1,482	–	–	6,796	14,826
Electrical Equipment	–	–	–	–	0	40	55	363	–	–	55	403
Project Controlling	342	147	951	408	587	252	438	188	–	–	2,318	995
Sub Total	639	3,112	2,741	7,673	3,023	3,406	2,766	2,033	–	–	9,169	16,224
Interest during Construction Period	30	148	191	660	465	1,187	740	1,445	871	1,541	2,297	4,981
Grand Total	669	3,260	2,932	8,333	3,488	4,593	3,506	3,478	871	1,541	11,466	21,205
(II) without Tax												
Transmission Line	0	2,965	1,063	7,265	2,125	3,114	2,125	1,482	–	–	5,313	14,826
Electrical Equipment	–	–	–	–	0	40	50	363	–	–	50	403
Project Controlling	342	147	951	408	587	252	438	188	–	–	2,318	995
Grand Total	342	3,112	2,014	7,673	2,712	3,406	2,613	2,033	–	–	7,681	16,224
Economic Cost												
Transmission Line	0	2,965	721	7,265	1,441	3,114	1,441	1,482	–	–	3,603	14,826
Electrical Equipment	–	–	–	–	0	40	38	363	–	–	38	403
Project Controlling	270	147	751	408	464	252	346	188	–	–	1,831	995
Grand Total	270	3,112	1,472	7,673	1,905	3,406	1,825	2,033	–	–	5,472	16,224

Table AP.5–5 Estimated Construction Cost
(for Artvin Project)

(10^6 T.L.)

Description	D.C.	F.C.	Total
Financial Cost			
(I) with Tax			
Transmission Line	3,964	8,649	12,613
Electrical Equipment	32	236	268
Project Controlling	1,353	581	1,934
Sub Total	5,349	9,466	14,815
Interest during Construction Period	1,340	2,905	4,245
Grand Total	6,689	12,371	19,060
(II) without Tax			
Transmission Line	3,098	8,649	11,747
Electrical Equipment	29	236	265
Project Controlling	1,353	581	1,934
Grand Total	4,480	9,466	13,946
Economic Cost			
Transmission Line	2,100	8,649	10,749
Electrical Equipment	22	236	258
Project Controlling	1,068	581	1,649
Grand Total	3,190	9,466	12,656

Table AP.5–6 Fund Requirement in Each Year (for Artvin Project)

(10^6 T.L.)

Description	1st Year (5th)		2nd Year (6th)		3rd Year (7th)		4th Year (8th)		5th Year (9th)		Total	
	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.	D.C.	F.C.
Financial Cost												
(I) with Tax												
Transmission Line	173	1,730	1,044	4,238	1,421	1,816	1,326	865	-	-	3,964	8,649
Electrical Equipment	-	-	-	-	0	24	32	212	-	-	32	236
Project Controlling	200	86	555	238	342	147	256	110	-	-	1,353	581
Sub Total	373	1,816	1,599	4,476	1,763	1,987	1,614	1,187	-	-	5,349	9,466
Interest during Construction Period	18	86	111	385	271	692	432	843	508	899	1,340	2,905
Grand Total	391	1,902	1,710	4,861	2,034	2,679	2,046	2,030	508	899	6,689	12,371
(II) without Tax												
Transmission Line	0	1,730	620	4,238	1,239	1,816	1,239	865	-	-	3,098	8,649
Electrical Equipment	-	-	-	-	0	24	29	212	-	-	29	236
Project Controlling	200	86	555	238	342	147	256	110	-	-	1,353	581
Grand Total	200	1,816	1,175	4,476	1,581	1,987	1,524	1,187	-	-	4,480	9,466
Economic Cost												
Transmission Line	0	1,730	420	4,238	840	1,816	840	865	-	-	2,100	8,649
Electrical Equipment	-	-	-	-	0	24	22	212	-	-	22	236
Project Controlling	158	86	438	238	270	147	202	110	-	-	1,068	581
Grand Total	158	1,816	858	4,476	1,110	1,987	1,064	1,187	-	-	3,190	9,466

A-6 DATA PROVIDED BY EIE

A–6 Data Provided by EIE

A–6 Data Provided by EIE

6.1 Meteorology and Hydrology

Item	Notes
(1) Daily discharge data of stations	No. 2302, 2304, 2305, 2314, 2315, 2316, 2318, 2320, 2321, 2322, 2323, 23325
(2) Daily Precipitation data of stations	Meydancik, Savsat, Ardanuc, Sarigol, Senkaya, Tortum, Kirik, Yusufeli, Sarimese, Aydintepe, Bayburt, Ispir, Olur, Narmon, Oltu, Pazaryolu, Camlikaya, Kilickaya
(3) Rating curves of stations	No. 2305, 2321, 2322, 2323
(4) Daily discharge data of DSI's stations	No. 23 - 13, 23 - 4
(5) Monthly evaporation data of stations	Bayburt, Ispir
(6) Design flood flows of existing and planned dams in Turkey including characteristics of river basin	
(7) Suspended sedimentation data of stations in turkey	
(8) Total sediment volume (dead volume) of existing dams in Turkey	
(9) Precipitation and vapor pressure data during selected historical storms	
(10) 1982 Water Year Discharge "published by EIE in 1985	
(11) Location map of dams and hydropower plants which are existing, under construction or planned in turkey	
(12) Location map of stream gaging stations, sediment stations and snow course stations	
(13) Location map of meteorological stations and stream gaging stations within the basin	
(14) Wind velocity and wind direction measured at various height above Samsun City	

Item	Notes
(15) Daily temperature of Bayburt station	
(16) Backing data concerning flood discharge calculation due to snowmelt as was carried out by EIE	
(17) Specific sediment per square kilometer evaluated at stations in Turkey	
(18) Annual peak discharges observed at stream gaging stations in Coruh river	
(19) Enveloping curves of monthly maximum vapor pressures	
(20) Hydrology report titled "UNESCO-Uluslararasi Hidroloji Programi (UHP) Turkiye"	
(21) "Report on Engineering Hydrology for Kargi and Guraogut Dama on Sakarya River" Volume I, II, III	
(22) Staff gage reading of Coruh river water level 200 m downstream of Inanli damsite	
(23) Wind velocity and wind direction during selected historical storms at Bayburt and Artvin	
(24) Maximum 12-hour persisting vapor pressures for each month in every year	
(25) Daily precipitation data during selected historical storms at stations around the basin	
(26) Catchment area of alternative Inanli damsite	Upstream damsite : 15,400 km^2 Downstream damsite: 15,540 km^2

6.2 Geology

Item	Notes
(1) Geological map of Yusufeli reservoir	1 : 25000
(2) Geological map of Yusufeli damsite	1 : 1000
(3) Geological profile of Yusufeli damsite	1 : 1000
(4) Coordination of drillholes and adits	
(5) Logs of drillholes and adits	
(6) Groundwater measurement record	
(7) Geological map of Inanli reservoir	1 : 25000
(8) Location map of investigation works at Inanli damsite (Plan)	1 : 1000
(9) Ditto (Profile)	
(10) Geological map of Inanli tunnel	1 : 1000
(11) Geological profile of Inanli tunnel	1 : 5000
(12) List of drillholes and adits at Inanli damsite	
(13) Logs of drillholes	
(14) Data of permeability test at Inanli damsite	
(15) Location map of drillholes at Havuzlu landslide	
(16) Geological plan at Inanli damsite (existing site)	
(17) Logs of adits at Inanli damsite (existing site)	
(18) Data of seismic prospecting at Havuzlu landslide	
(19) Data of seismic prospecting along adits at Yusufeli damsite	
(20) Some geological data along Inanli tunnel near Esenkaya village	

Item	Notes
(21) Results of soil tests at Tortum landslide, Vecaket landslide, Havuzlu landslide and Demirkent landslide	
(22) Geological log of adit LA-2 (50 m from TD 76 m to TD 126.75 m)	
(23) Geological logs of drillholes RSI-16 and ST-1	
(24) Photographs for the shear tests	
(25) Geological map of Inanli downstream damsite	1/2,000
(26) Surface geological investigations based on the new topographic map at Yusufeli dam site	
(27) Various investigations at Inanli downstream dam site	

6.3 Development Planning

Item	Notes
(1) Topographical maps scale: 1/5,000 covering reservoir area of Yusufeli and Inanli projects	66 sheets
(2) Characteristics of Coruh River basin	
(3) Water resource development plan of Coruh River basin	
(4) Salient features of existing reservoir type power stations in Turkey	
(5) Major Items of investment cost for hydropower project	
(6) Reservoir elevation-compensation cost curve of Yusufeli reservoir	
(7) Reservoir elevation-compensation cost curve of Inanli reservoir	
(8) Survey and investigation cost and administration cost of existing projects in Turkey	
(9) Salient features of Karakale, Artvin, Borcka and Muratli projects (including storage capacity curve)	
(10) Reservoir water level-storage capacity curve and water level-area curve of Yusufeli and Inanli projects (scale: 1/5,000)	
(11) Definition of firm power, firm energy and secondary energy	
(12) Operation and maintenance cost of major hydropower plants	
(13) Artvin, Borcka, Muratli barajlari ve Hes Yapilabilirlik Ara Raporu (Artvin, Borcka, Muratli dam and powerstation Interim Report of Feasibility Study 1984)	
(14) Yusufeli Damsite Expropriation Values Report	

Item	Notes
(15) Inanli Damsite Expropriation Values Report	
(16) Topographical maps scale: 1/1,000 covering Yusufeli dam site	
(17) Area and population (as of 1980)	
(18) General conditions of Artvin province	
(19) River cross section and rating curves	

6.4 Project Design

Item	Notes
(1) A probabilistic assessment of the seismic hazard in Turkey	
(2) Report on the Turkish eashquake of October 30, 1983	
(3) Regional rearrangement of earthquake catalogues of Turkey	

6.5 Construction Planning and Cost Estimation

Item	Notes
(1) Location of project area and access possibilities	
(2) Ekonomik Etud Tablolari 1984 (Unit prices of construction works of roads)	
(3) Unit construction costs in 1985 of civil works established by DSI	
(4) Material cost	
(5) Labor cost	
(6) Unit construction cost, construction schedule and quantities of Oymapinar project	
(7) Inland transportation	

6.6 Electric Power Situation

Item	Notes
(1) Targets and performance of long-range plane (growth rate)	
(2) Economic activity	
(3) Population actual and estimated	
(4) Installed generating capacity	
(5) Energy generated per capita	
(6) Monthly maximum demand	
(7) Basic data for demand forecast	
(8) Electricity demand forecast by TEK	
(9) Energy balance	
(10) Breakdown of energy generated in a selected month	
(11) Gross energy generated	
(12) Electrification ratio	
(13) Major hydraulic power stations under construction	
(14) Power development plan in Turkey	
(15) Total of hydraulic power station projects in Turkey	
(16) Construction schedule of power stations in Turkey	
(17) Production schedule of available energy generated	
(18) Transmission and distribution lines	
(19) Loss and drop of voltage	
(20) Power demand forecast method in Turkey	

Item	Notes
(21) Expanded development plan of power system in project area and the project plan of transmission line and substation	
(22) Current situation and future plan of power dispatching system	
(23) Typical daily demand curve in 1984 or 1983	
(24) Daily load curve of selected date of typical month	
(25) Planning data of telecommunication system for the project	
(26) System of electricity tariff	
(27) Receiving point of electric power for construction and capacity of existing substation	
(28) Major plants in operation shown in Tables-22 to 25.	
(29) Plants's name and figures are checked by EIE.	
(30) Long term electric power development scheme 1982	
(31) Construction schedule of power stations in Turkey (average and continuous capacity)	
(32) Turkiye Elektrik Istatistikleri Ozeti (1984 Yili Sonu)	
(33) Turkiye Elektrik Enerjisi Talep Tahmin Calismalari (1984 - 2000)	

6.7 Transmission Line

Item	Notes
(1) Construction cost of 154 kV transmission line in 1984	
(2) Unit prices for transmission lines in 1985	

6.8 Economic Evaluation

Item	Notes
(1) TEK's annual reports 1984, 1983, and 1982	
(2) TEK's annual production cost in 1984	
(3) Basic criteria of economic analysis	
(4) Loan condition	
(5) Unit price of imported energy in 1984, Bulgaria and U.S.S.R.	
(6) Commence year of Yusufeli and Inanli project	
(7) Electric Tariff	
(8) Distribution ratio of electricity to local demand	
(9) Alternative thermal	
(10) Operation Activities Report	May 1985, August 1983, December 1984
(11) Construction and operational cost of lignite thermal power plant	For reference only
(12) Annual report of TKI	For reference only

6.9 Master Plan Report for Coruh River Basin Prepared by EIE (1982)

Item		Notes
(1) Master Plan	Volume 1	
(2) Master Plan	Volume 2	
(3) Master Plan	Volume 3	
(4) Hydrology	Volume 1	
(5) Hydrology	Volume 2	
(6) Geology		
(7) Drawings