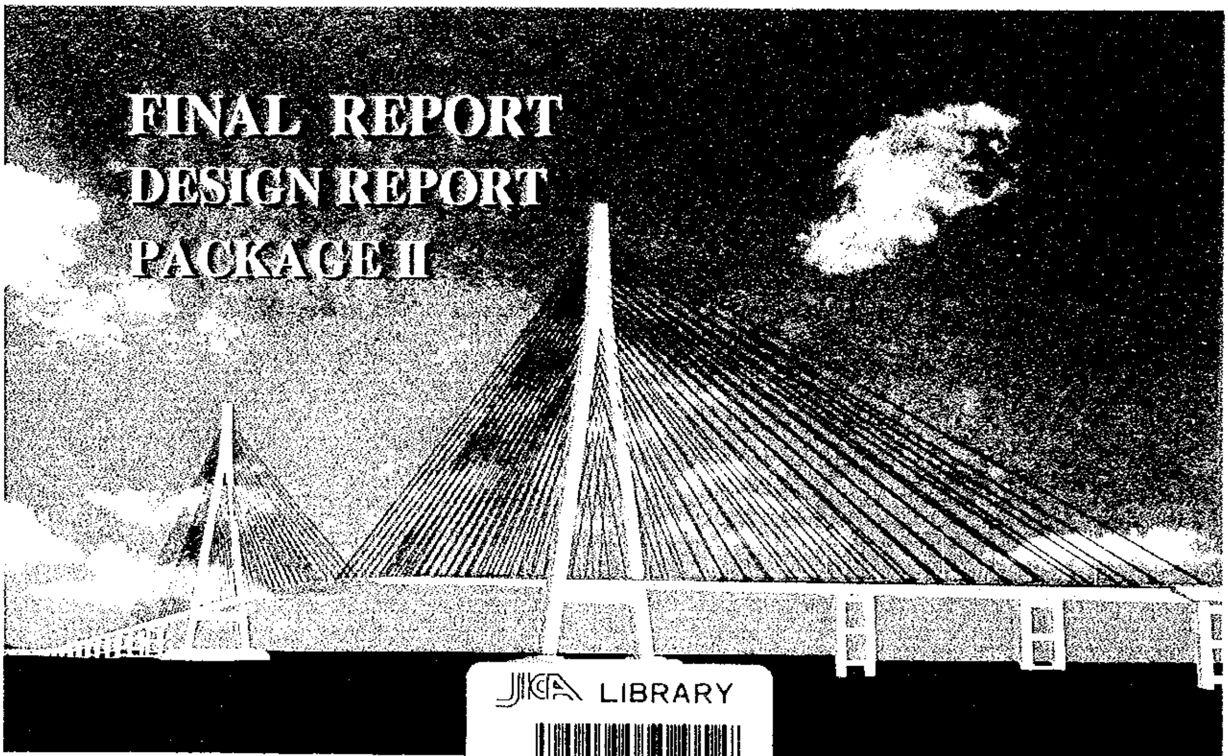
社会開発調査部報告書

No. 32

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT
SOCIALIST REPUBLIC OF VIET NAM

THE DETAILED DESIGN ON THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM



OCTOBER 2000

NIPPON KOEI CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
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FINAL REPORT
DESIGN REPORT
PACKAGE II

OCTOBER 2000

NIPPON KOEI CO., LTD.

FINAL REPORT
ON
THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION
IN
SOCIALIST REPUBLIC OF VIET NAM

DESIGN REPORT
PACKAGE-II

Table of Contents

Chapter 1

GENERAL

1. General

1.1 Standard and Specifications

Name of Standards, Specification, or Guideline
Design Criteria for Bridge Design for The Can Tho Bridge Construction Project (1999)
AASHTO, LRFD specifications for Bridge Design (1998)
Design Specification for Highway Bridge and Culvert (22TCN18-79)
Japanese Highway and Bridge Standard

1.2 Geometry of Bridge

Type of Bridge

Main Bridge

7-Spans continuous Hybrid (P.C. and steel) cable stayed bridge

Span Arrangement 70+70+130+550+130+70+70=1090 m

Type of Girder: Pre-cast segment PC box girder Steel box girder

Type of Pylon: Reinforced concrete pylon

Foundation : Cast in Place Concrete pile Dia.1.50m, Dia.2.00m, Dia.3.00m

Pier name	Type of Substructure	Type of Foundation	Bearing condition
P12, P13, P14	2 - column Pier	Cast in situ Concrete Pile (Dia. 1,500,)	Elastomeric
Northern Pylon	A – Type Pylon	Cast in situ Concrete Pile (Dia. 3,000)	Elastomeric
Southern Pylon	A –Type Pylon	Cast in situ Concrete Pile (Dia. 3,000)	Elastomeric
P15, P16, P17	2-column Pier	Cast in situ Concrete Pile (Dia. 2,000)	Elastomeric

Elastomeric Bearing supports the force of vertical and longitudinal horizontal direction to flexibility.

Approach Viaduct and Branch Stream Bridge

Vinh Long side

Bridge Type : 3-spans Connection Composite I Girder

Span arrangement : 12@40m=480m

Substructure : reversed –T-type Abutment, 2-columns pier

Foundation : Cast in Place Concrete pile Dia.1.500m

Can Tho side

Bridge Type : 3,4spans Connection Composite I Girder

: 5spans Continuous PC Box Girder (Balanced Cantilever Method)

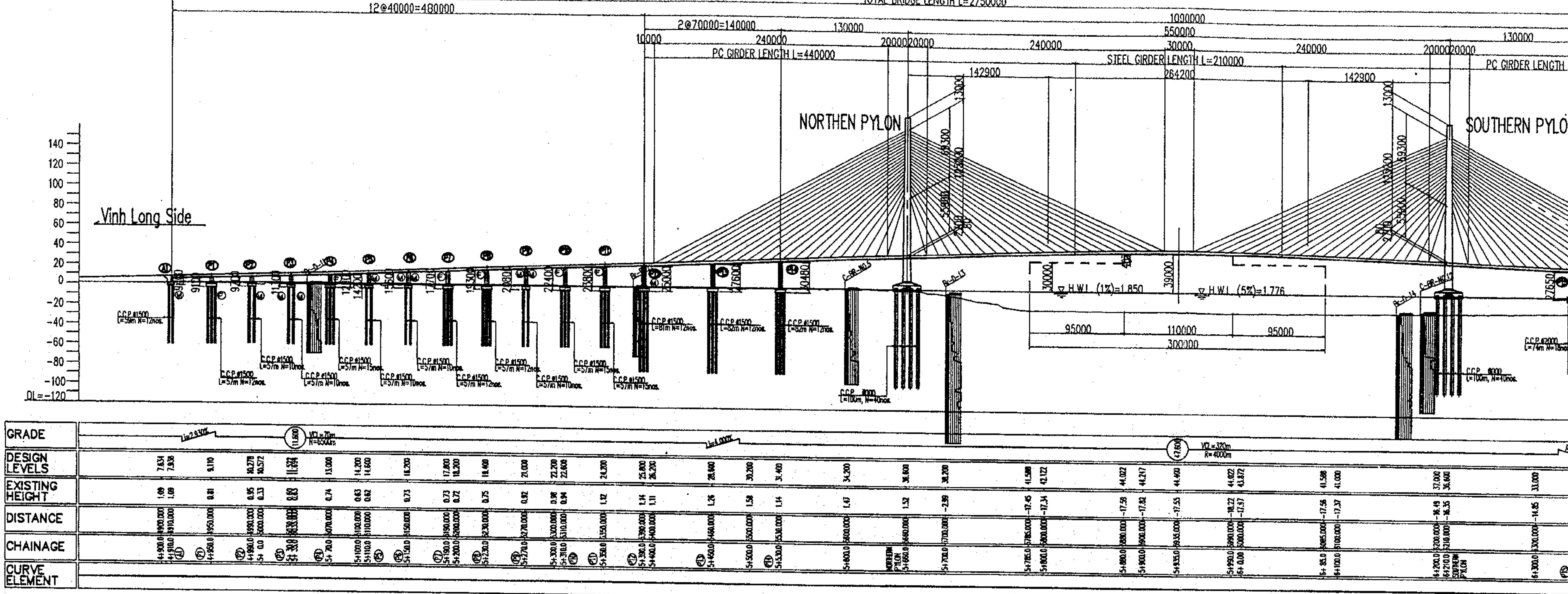
Span arrangement : 19@40m=760m, 50m+3@80m+50m=340m

2@40m=80m

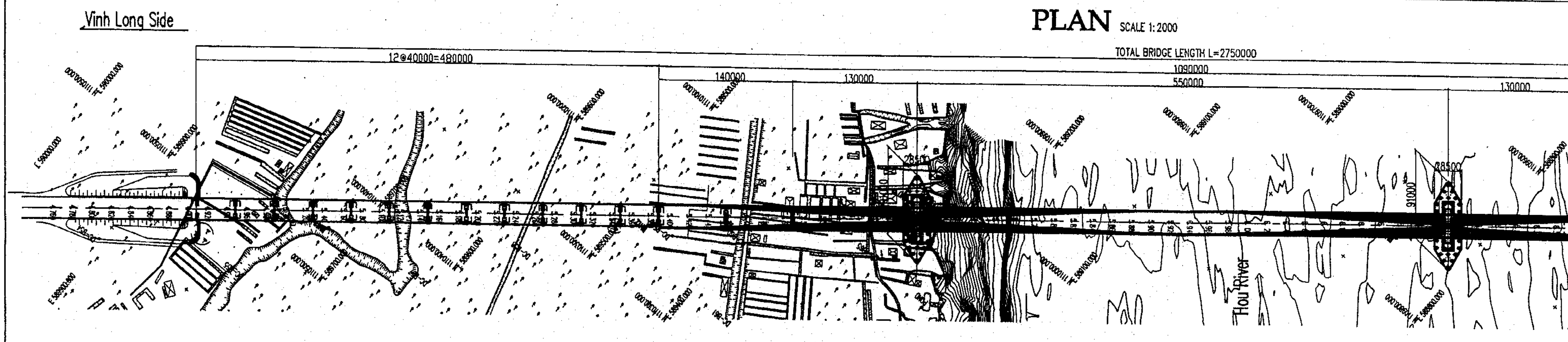
Substructure : reversed -T-type Abutment, 2-columns pier

Foundation : Cast in Place Concrete pile Dia.1.50m, Dia.2.00m

SIDE ELEVATION SCALE 1:4000

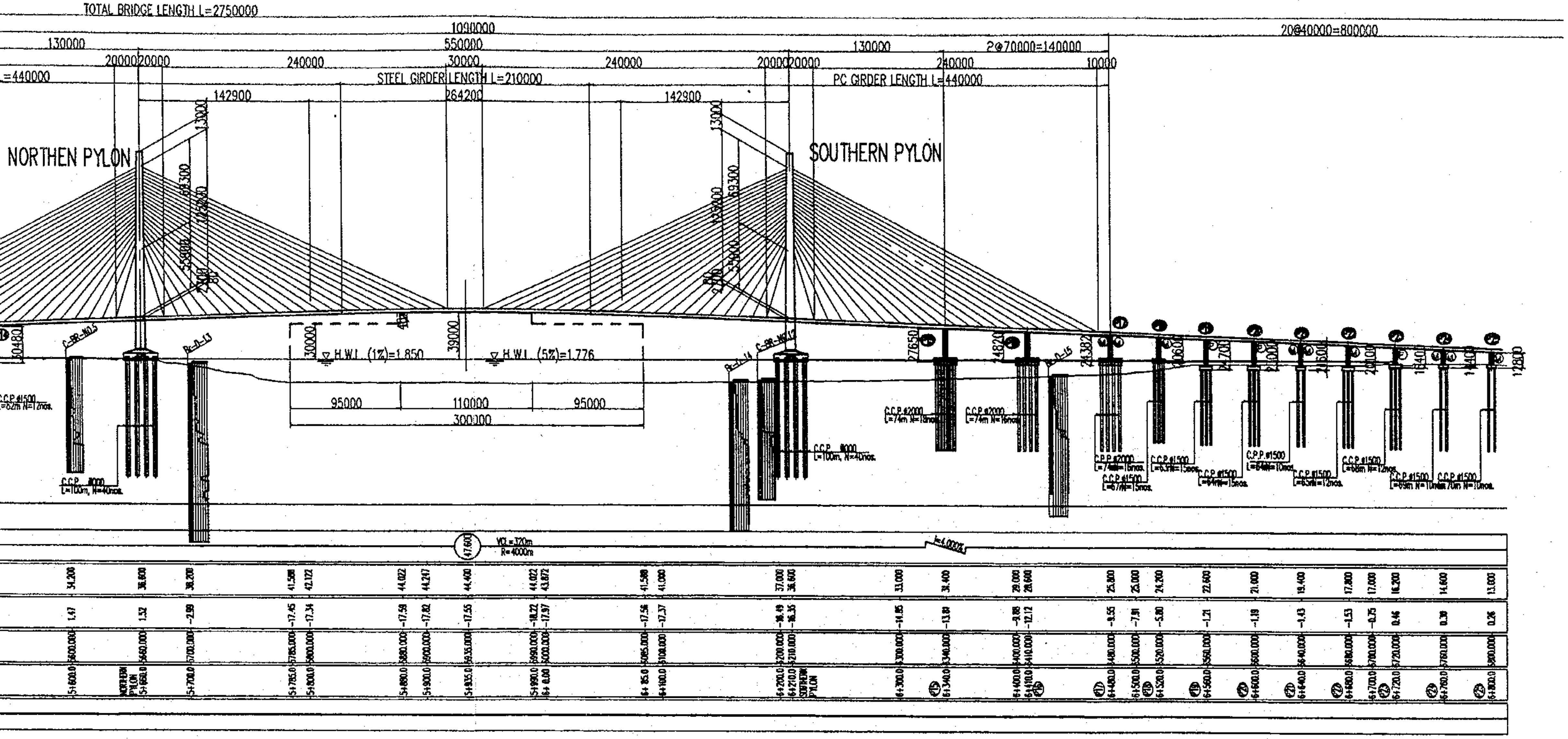


PLAN SCALE 1:2000



GENERAL VIEW (1/2)

SIDE ELEVATION SCALE 1:4000



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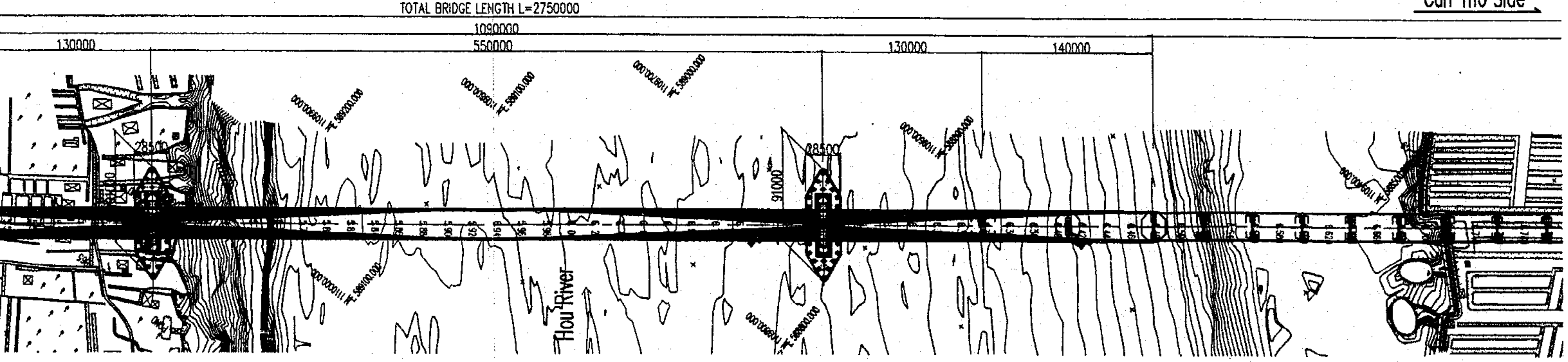
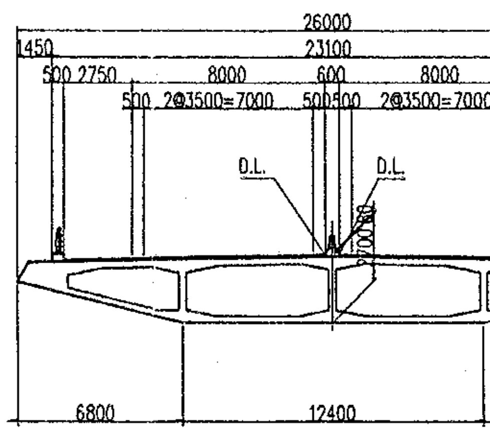
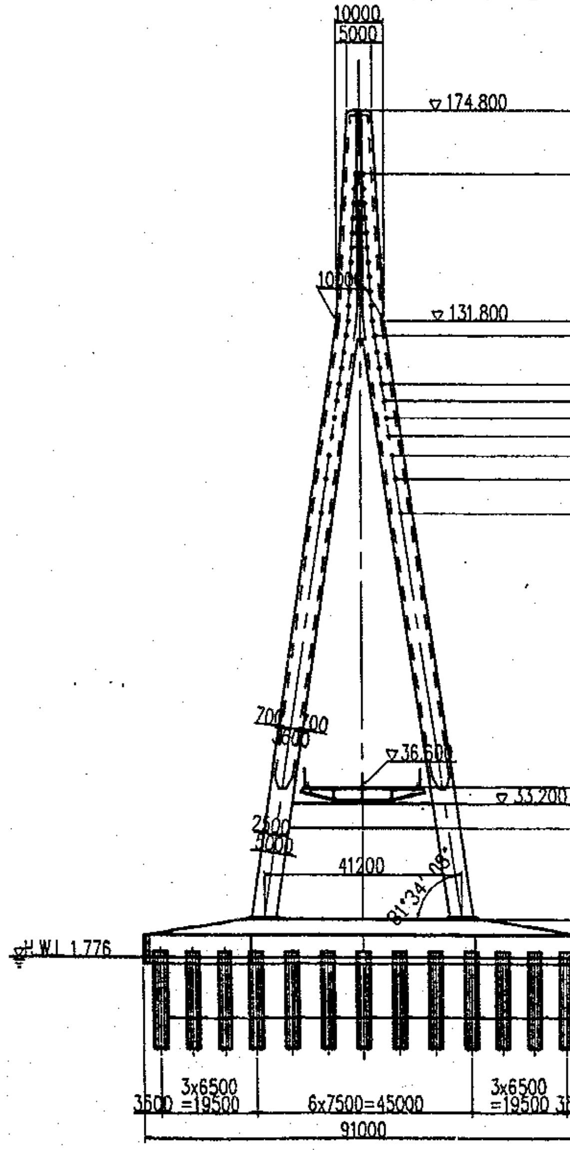


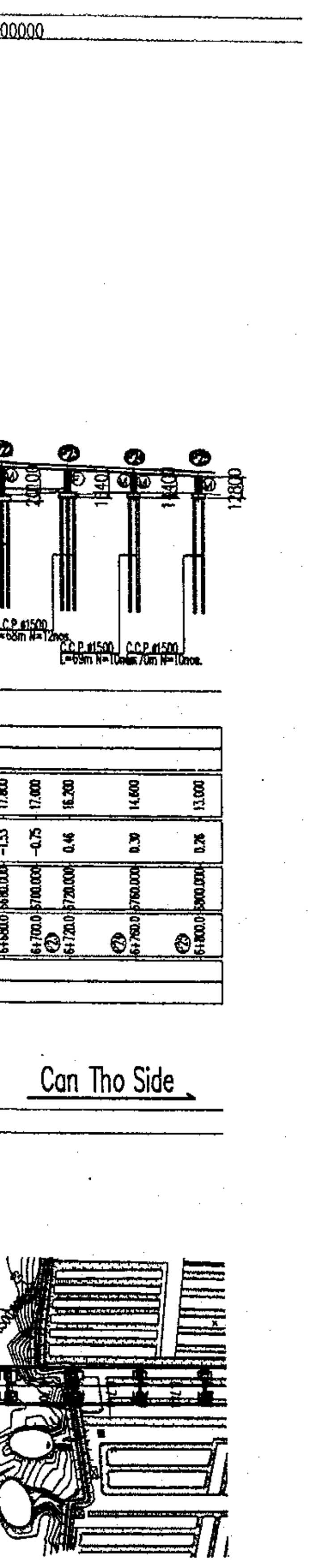
PC BOX GIRDER



PYLON (NORTHERN,SOUTHE
FRONT ELEVATION



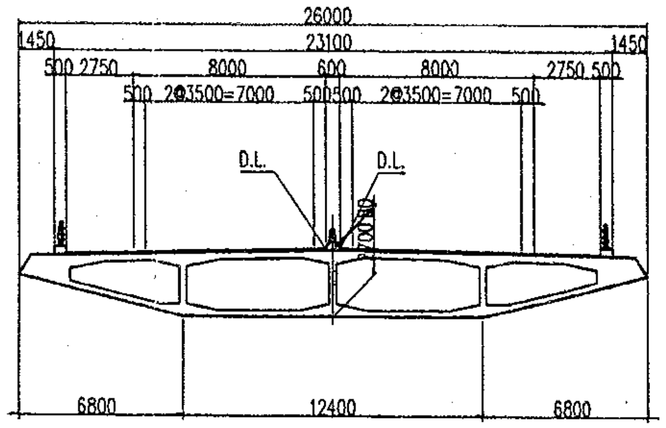
PROJECT NAME	IMPLEMENTATION AGENCY	EXEC
DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION PROJECT	JICA JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	SOCIALIST R MINISTRY O MY THUAN PRO



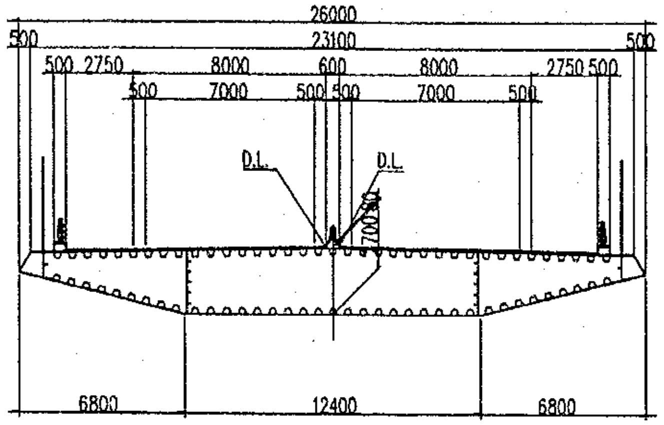
SUPERSTRUCTURE
SCALE 1:300

MAIN BRIDGE

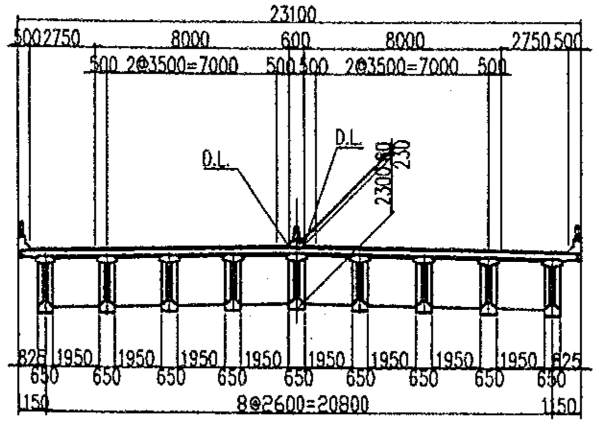
PC BOX GIRDER



STEEL BOX GIRDER

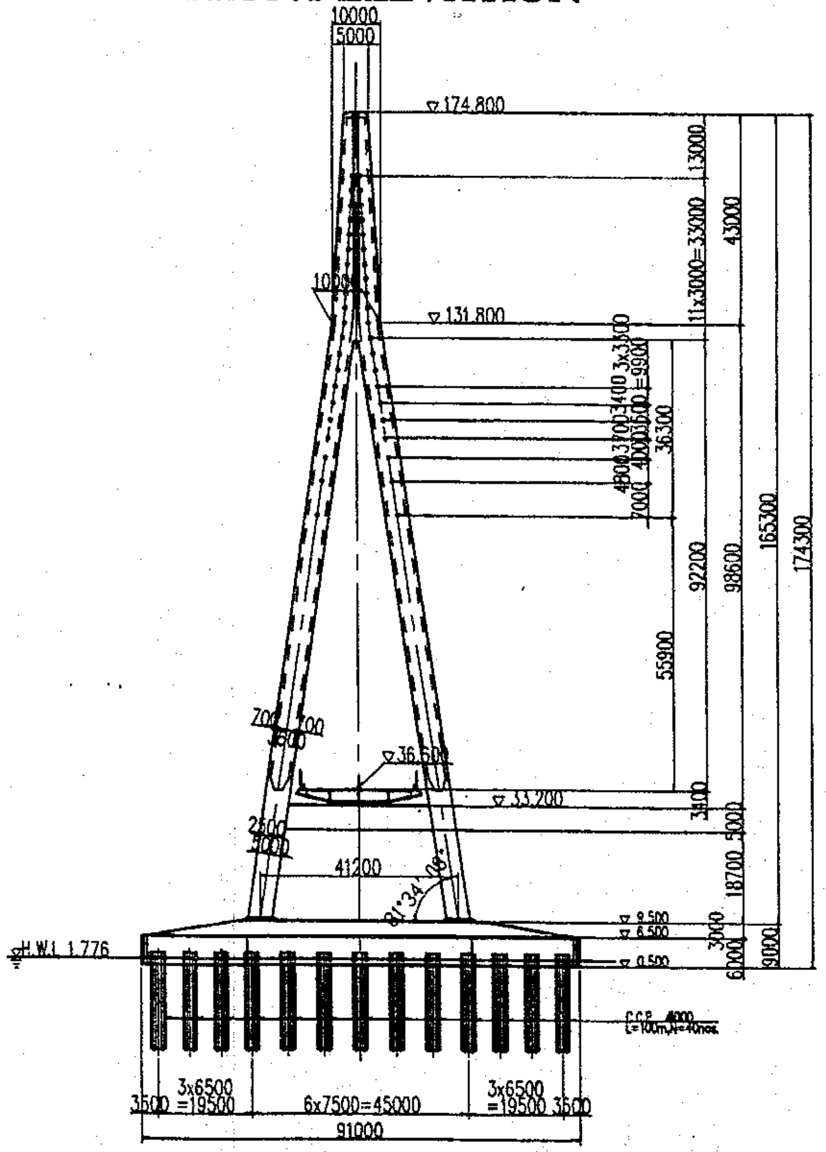


APPROACH BRIDGE
CONNECTED PC I GIRDER



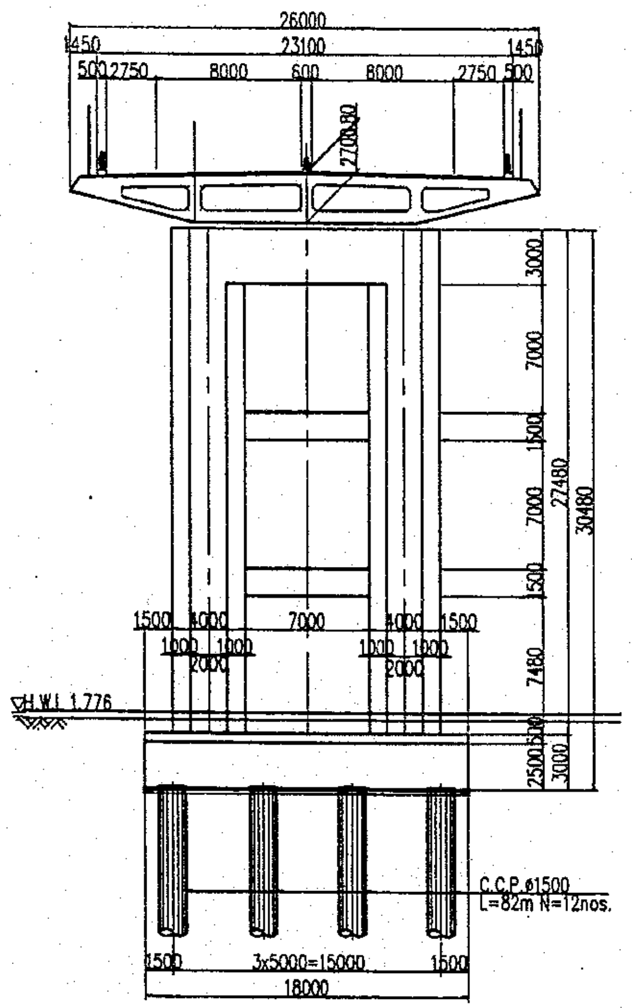
PYLON
SCALE 1:1500

(NORTHERN,SOUTHERN) FRONT ELEVATION

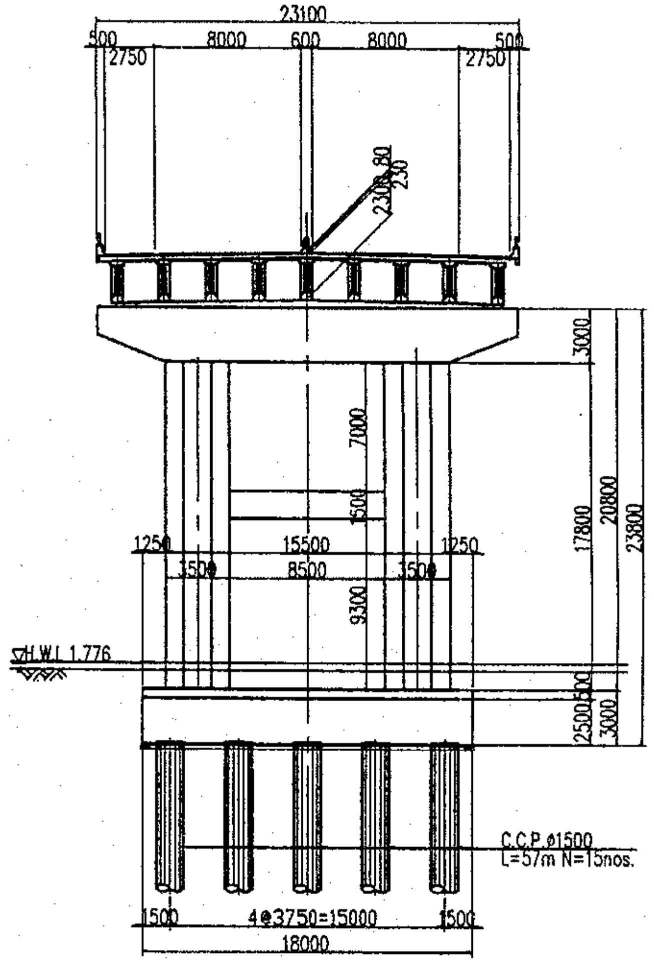


SUBSTRUCTURE
SCALE 1:400

MAIN BRIDGE
P14

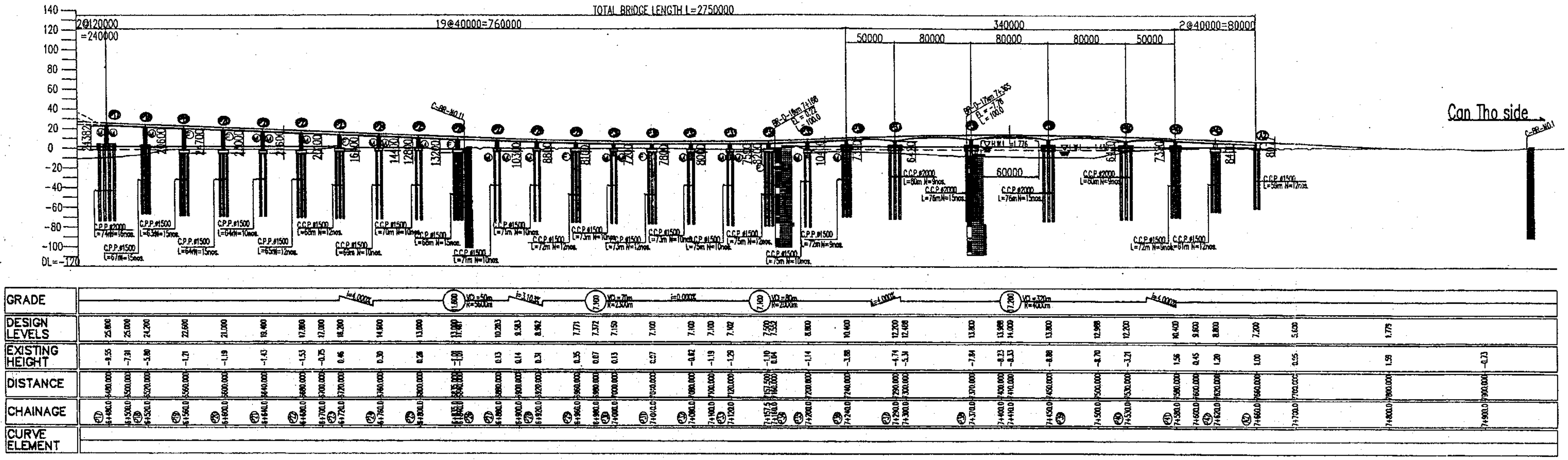


APPROACH BRIDGE
P11

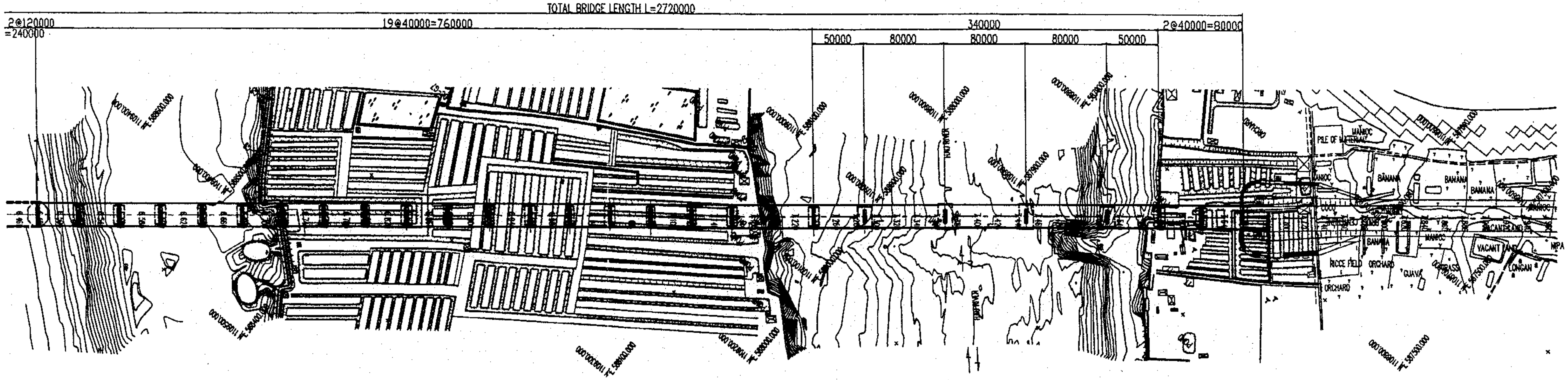


PROJECT NAME	IMPLEMENTATION AGENCY	EXECUTING AGENCY	JICA STUDY TEAM		PREPARED BY	CHECKED BY	APPROVED BY	DRAWING TITLE	DWG NO.
DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION PROJECT	JICA JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	SOCIALIST REPUBLIC OF VIET NAM MINISTRY OF TRANSPORT (MOT) MY THUAN PROJECT MANAGEMENT UNIT	NIPPON KOEI CO.,LTD.	NAME	S. Kiguchi	K.Matsumoto	K. Enomoto	General View of Can Tho Bridge (1/2)	1-3
				SIGNATURE	[signature]	[signature]	[signature]		
				DATE	20/9/2000	29/9/2000	5/10/2000		

SIDE ELEVATION
SCALE 1:4000

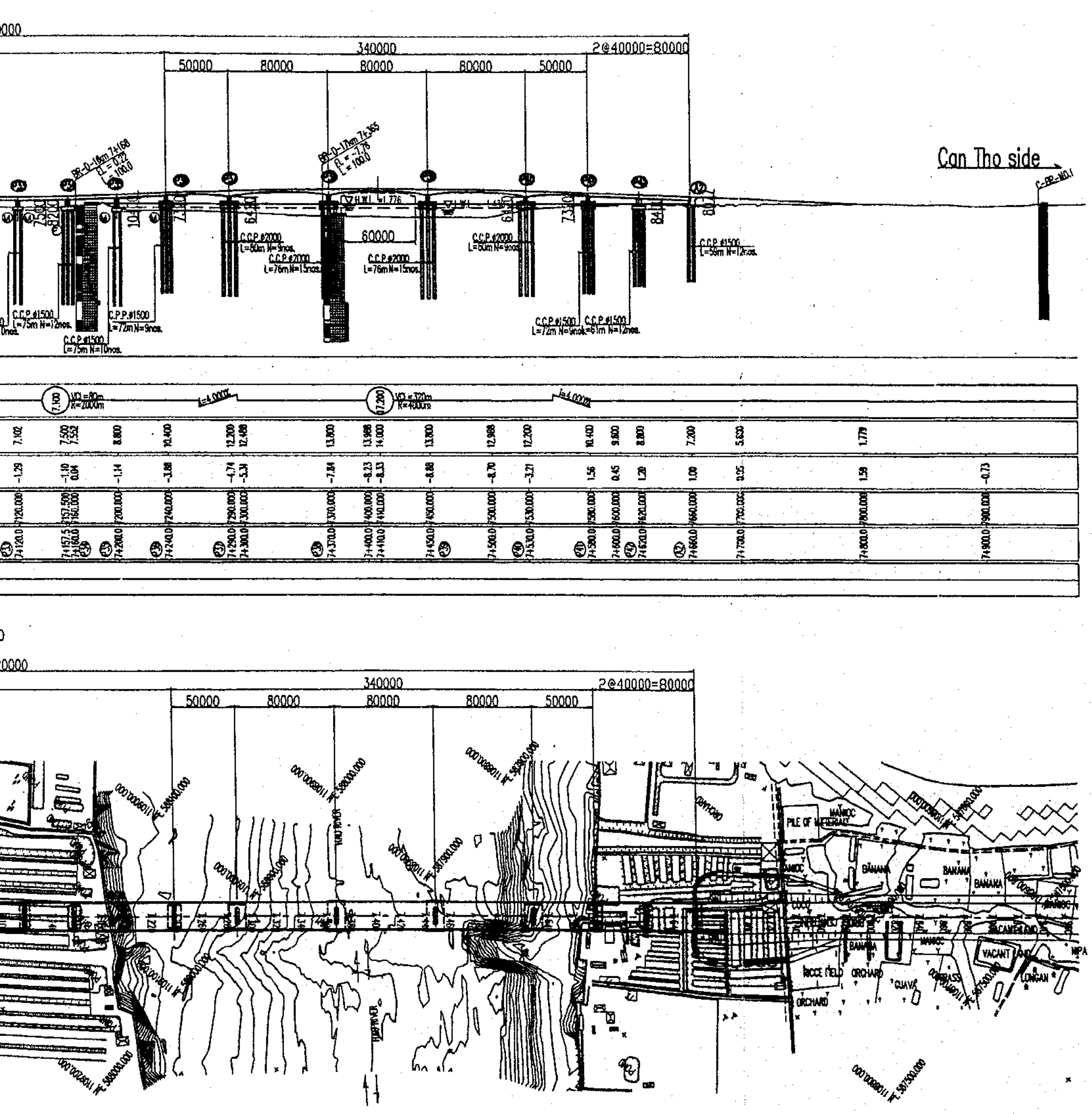


PLAN
SCALE 1:2000



GENERAL VIEW (2/2)

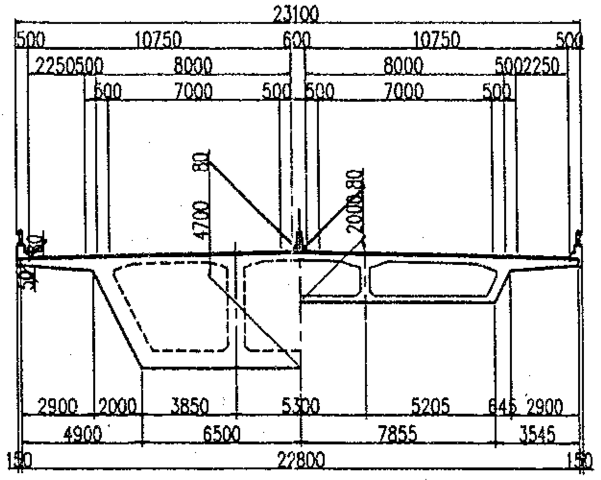
1:4000



SUPERSTRUCTURE SCALE 1:300

MAIN BRIDGE OF SUB-STREAM

PC BOX GIRDER



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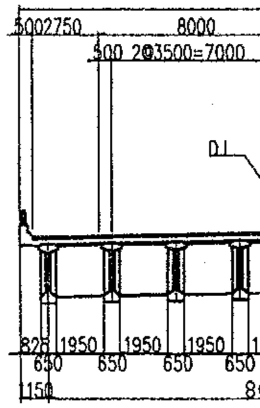
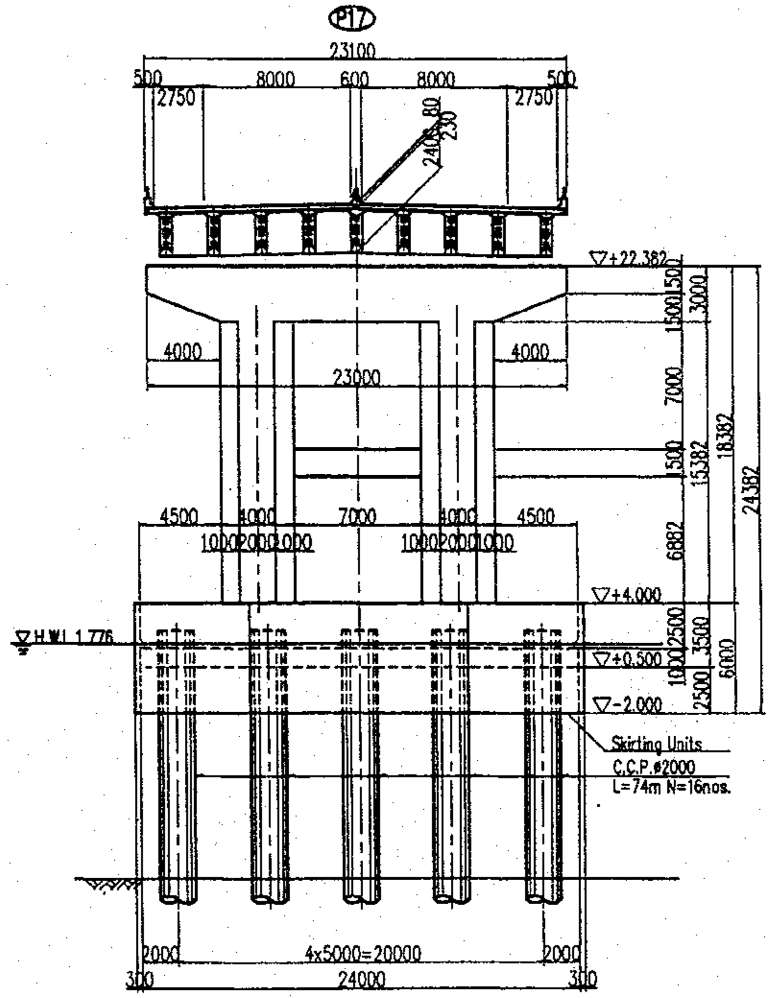
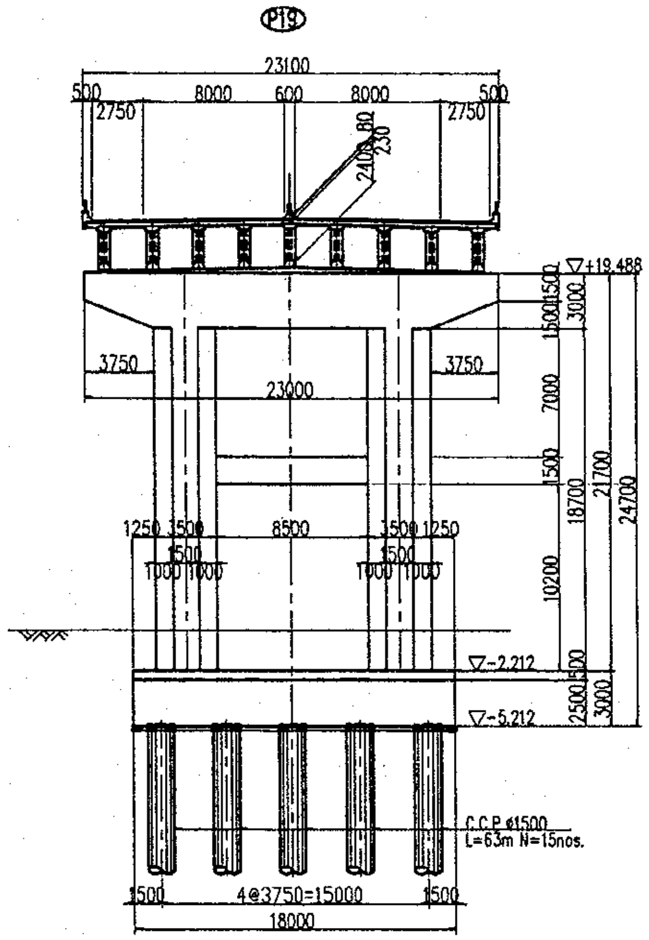
PC BO...



SUBSTRUCTURE





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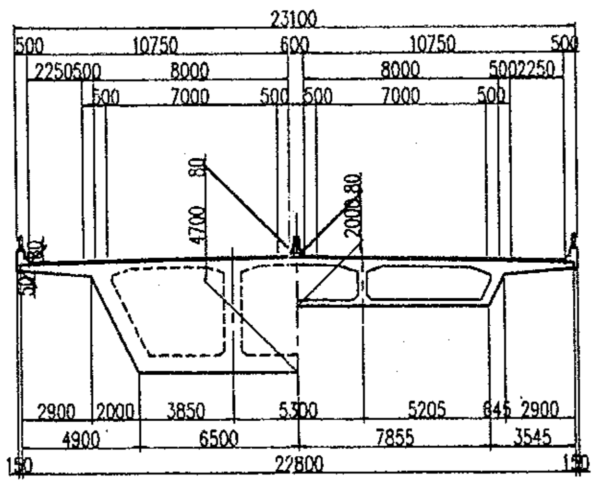
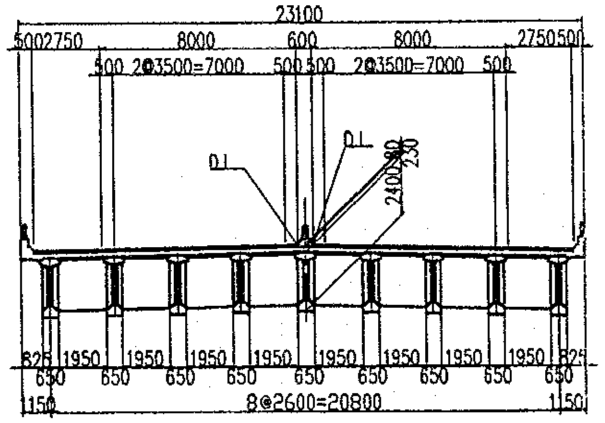
AL VIEW (2/2)

SUPERSTRUCTURE SCALE 1:300

MAIN BRIDGE OF SUB-STREAM
PC BOX GIRDER



APPROACH BRIDGE
PC BOX GIRDER



DESIGN CRITERIA

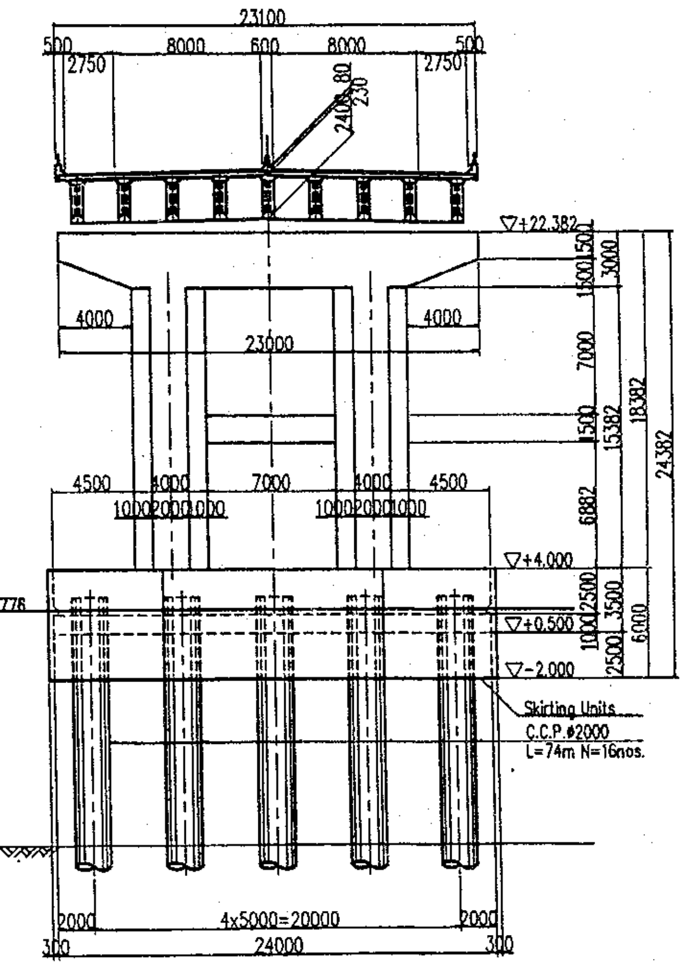
TYPE	HYBRID CABLE STAYED BRIDGE
TOTAL BRIDGE LENGTH	L=1090.000m
SPAN	2@70m+130m+550m+130m+2@70m
WIDTH	CARRIAGE WAY WIDTH=21.5m (10.75m+10.75m)
LIVE LOAD	B-LIVE LOAD
IMPACT COEFFICIENT	i=20/(L+50)
SEISMIC DATE	Kh=0.12
ANGLE OF SKEW	90° 00'00"
RADIUS OF CURVATURE	R=∞
LONGITUDINAL SLOPE	4.0% ↗ ↘ 4.0% V.C.L.=320m

MATERIALS

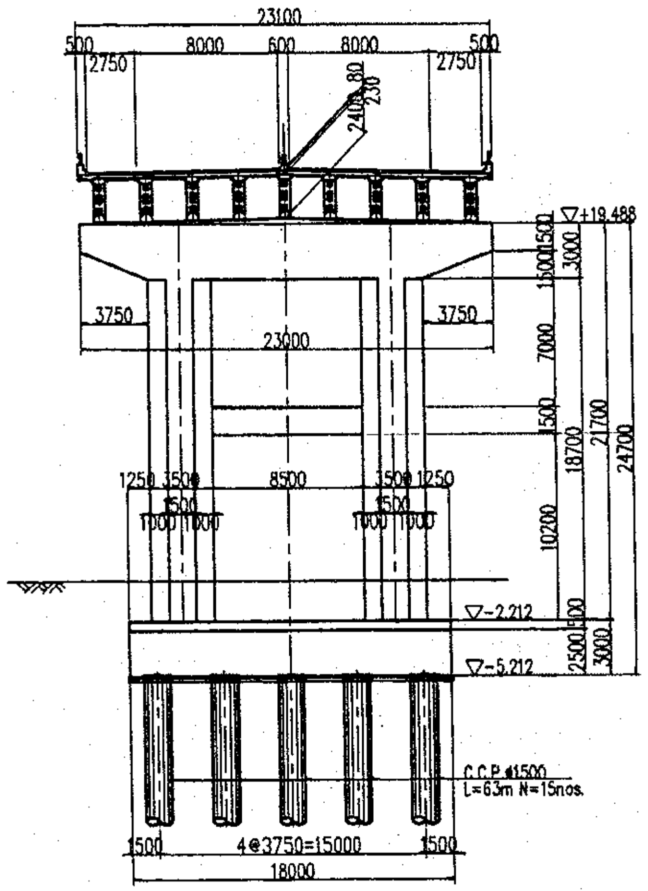
CONCRETE	GIRDER	σck=50MPa
	PYLON	σck=40MPa
	PILECAP OF PYLON	σck=30MPa
	SUBSTRUCTURE	σck=25MPa
	BORED PILE	σck=30MPa
PC STEEL	GIRDER	12S15.2B(SWPR7B),PC Bar Dia.32mm
	STAY CABLE	15.2B (SWPR7B)
STEEL	GIRDER	SS400,SMA400,SMA490

SUBSTRUCTURE SCALE 1:400

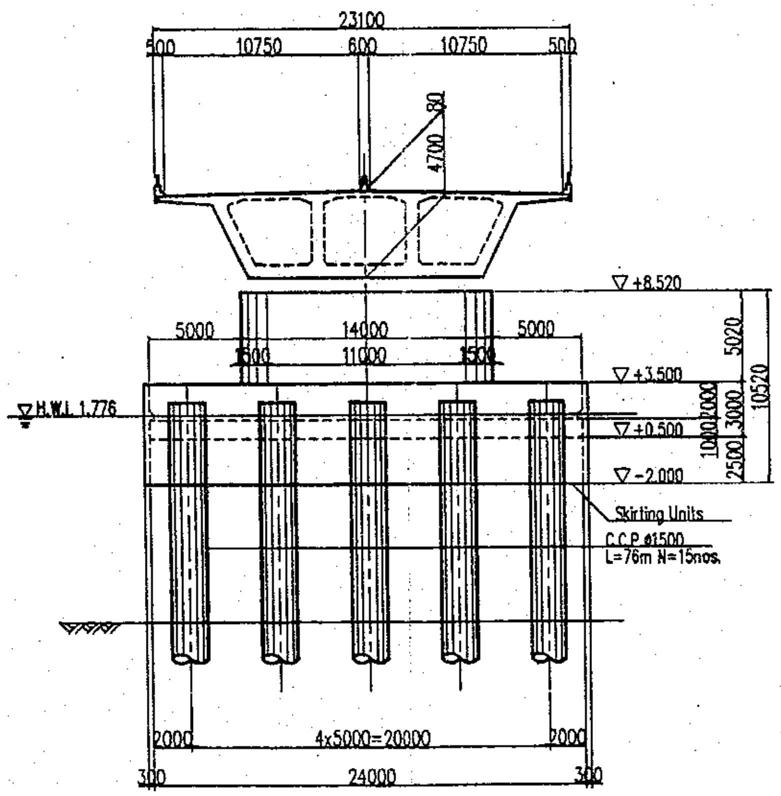
P17



P19



P38 P39



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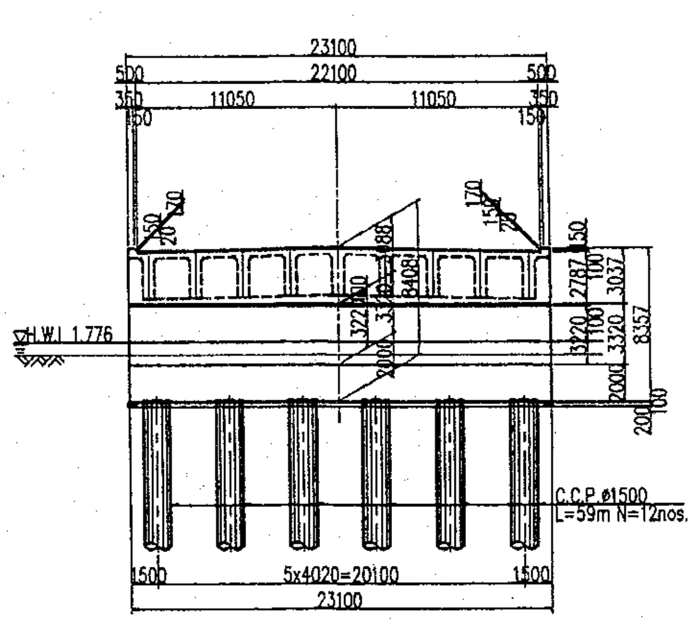

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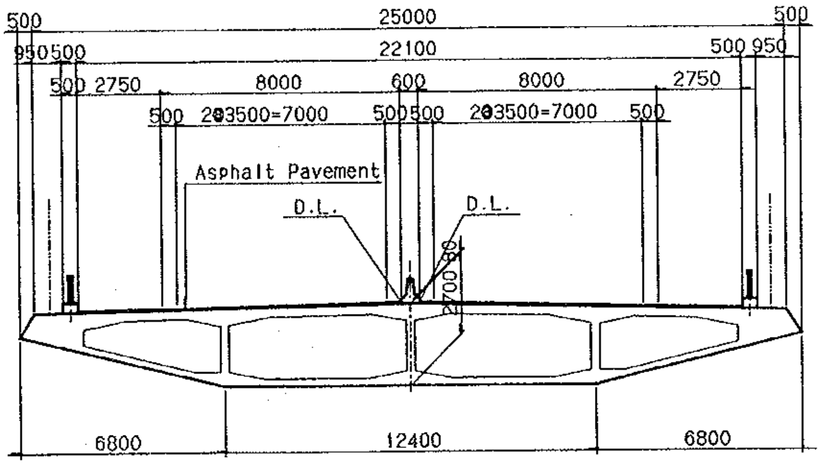
				SIGNATURE	S. Kiguchi	K. Matsumoto	[signature]		
				DATE	20/9/2000	29/9/2000	5/10/2000		

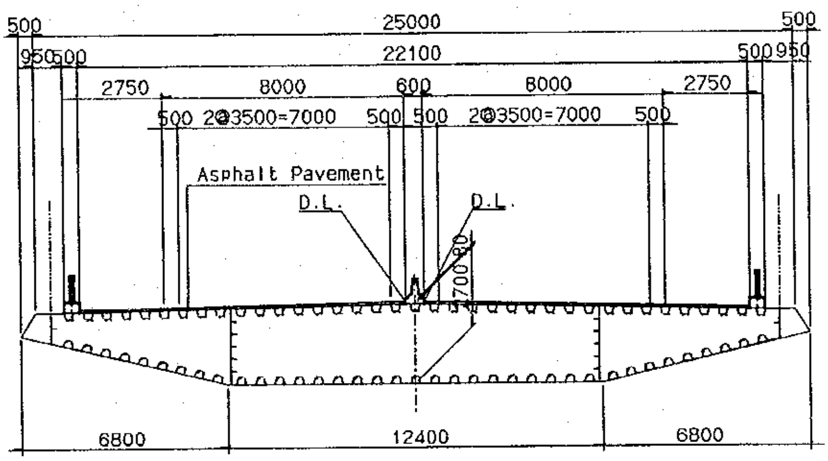
1.3 Cross Section

Typical Cross Section

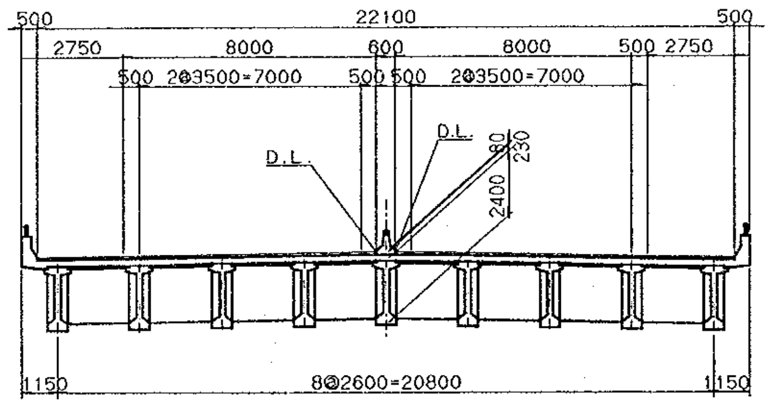
Main Bridge (PC Box Girder)



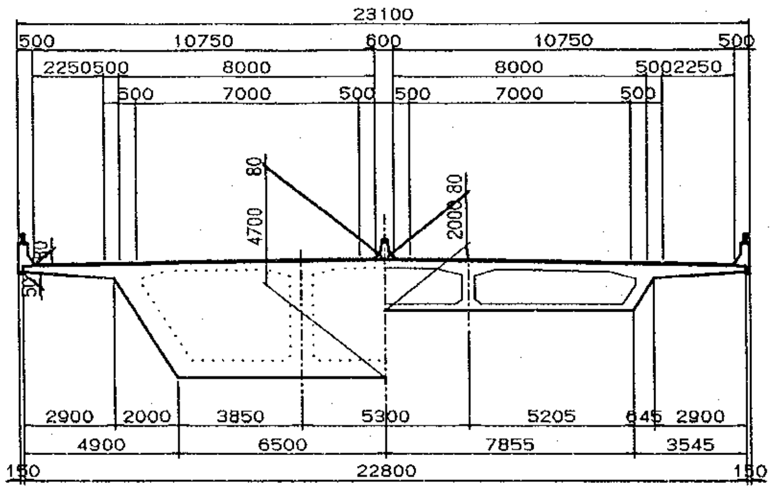
Main Bridge (Steel Box Girder)



Approach Viaduct



Branch Stream Bridge



1.4 Material

1.4.1 Concrete

Class	fc′	Typical use
A	50 MPa	Pre-cast concrete: PC Box Girders
B	40 MPa	In situ concrete: Pylons, PC Box Girders Pre-cast concrete: I Girders
C	35 MPa	In situ concrete: PC hollow slabs
D	30 MPa	In situ concrete : Diaphragm for I-girder, In situ concrete : Bored pile Pre-cast concrete: Skirt unit and slab for river pier and pile caps
E	25 MPa	Pre-cast concrete : Barrier In situ concrete : Pier, Abutment, Pile caps
F	20 MPa	In situ concrete : Concrete foot-path
G	15 MPa	In situ concrete : Lean Concrete, Plain Concrete

Class	fc′	Ec (MPa)	G (MPa)	Ct
A	50MPa	33,900	14,100	10.8/°C x 1.0E-6
B	40MPa	30,400	12,600	
C	35MPa	28,400	11,800	
D	30MPa	26,300	10,900	
E	25MPa	24,000	10,000	
F	20MPa	21,500	8,900	
G	15MPa	18,600	7,700	

* fc′: Compressive Strength of Concrete at 28 days (LRFD 5.4.2.1)

Ec: Elasticity Modulus of Concrete (LRFD 5.4.2.4) $Ec = 0.043Yc^{1.5}\sqrt{fc'}$

$Ec=4800\sqrt{fc'}$

G: Shear Modulus (LRFD5.4.2.5) G = Ec/(2 x (1+Poisson's ratio)) = Ec/2.4

Ct: Coefficient of thermal expansion and contraction (LRFD5.4.2.2)

1.4.2 Structural Steel

(1) Steel Girder

Grade		Minimum Yield Point or Minimum Yield Strength (N/mm^2)				Minimum Tensile Strength (N/mm^2)	Remarks
		Thickness of Steel					
		$t \leqq 16$	$16 < t \leqq 40$	$40 < t \leqq 75$	$75 < t$		
Rolled Steels for General Structure	SS400	245	235	215	215	400 ~ 510	JIS G 3101
Rolled Steels for Welded Structure	SM400A	245	235	215	215	400 ~ 510	JIS G 3106
	SM490YA	365	355	335	325	490 ~ 610	JIS G 3106
	SM490YB	365	355	335	325	490 ~ 610	JIS G 3106
Hot-rolled Atmospheric Corrosion Resisting Steels for Welded Structure	SMA400AW	245	235	215	215	400 ~ 510	JIS G 3114
	SMA400CW	245	235	215	215	400 ~ 510	JIS G 3114
	SMA490AW	365	355	335	325	490 ~ 610	JIS G 3114
	SMA490BW	365	355	335	325	490 ~ 610	JIS G 3114
	SMA570W	460	450	430	420	570 ~ 720	JIS G 3114
High Strength Hexagon Bolt for Friction Grip Type(H.T.B)	F10TW	900				1000~1200	JIS B 1186 Type Weathering Bolts
High Strength Tension Control Bolt for Friction Grip Type (T.C.B)	S10TW	900				1000~1200	JIS B 1186 Type Weathering Bolts
Stainless Steel NUT	SUS304						JIS B 1181
PIPE	STK400	235				400	JIS G 3444

(2) Steel Pipe for Hybrid Pile

Grade	Minimum Yield Point or Minimum Yield Strength (N/mm^2)	Minimum Tensile Strength (N/mm^2)	Remarks
SKK490	315	490	JIS A 5525

1.4.3 Reinforcement Steel

GRADE : SD345

- Specified Yield Strength:
  Plain Round: 235MPa High Yield deformed: 390MPa
- Modulus of elasticity of reinforcement steel: Es = 200,000 MPa

Available size of reinforcement

Dia. (mm)	Area (mm^2)	Mass N/m	Dia. (mm)	Area (mm^2)	Mass N/m
10	78.54	6.05	28	615.8	47.37
12	113.1	8.71	30	706.9	54.43
14	153.9	11.87	32	804.2	61.88
16	201.1	15.49	35	956.6	73.65
18	254.5	19.61	38	1140.0	87.76
20	314.2	24.22	41	1340.0	102.97
22	380.1	29.22	51	2002.7	155.93
25	490.9	37.76			

1.4.4 PC Steel

	Internal (Longitudinal)	Longitudinal PC Bar	Diaphragm at Stay PC anchorage
Grade	SWPR7BL	SBPR1180	SWPR7BL
Type of PC Steel	12S15.2	PC bar dia.32mm	12S15.2
Sectional Area (mm^2)	1,664.5	804.2	1664.5
Nominal Strength (N/mm^2)	1,860	1,180	1,860
Yield Strength (N/mm^2)	1,570	930	1,570
Young's Modules (MPa)	196,000	197,000	196,000
Friction Loss Coefficient (/m)	0.002	0.002	0.002
Angle Coefficient (/Deg.)	0.25	0.25	0.25
Set Losses (mm)	9	0	9

1.4.5 Stay Cable

The stays will be composed of 7 wire 15.2mm diameter strands with and elastic modulus Es = 195 x 10^3 MPa (adopted for design purposes.)
The effective stay modulus depends on the slope and the force in the stay according to the Ernst formula. Refer to the following formula.

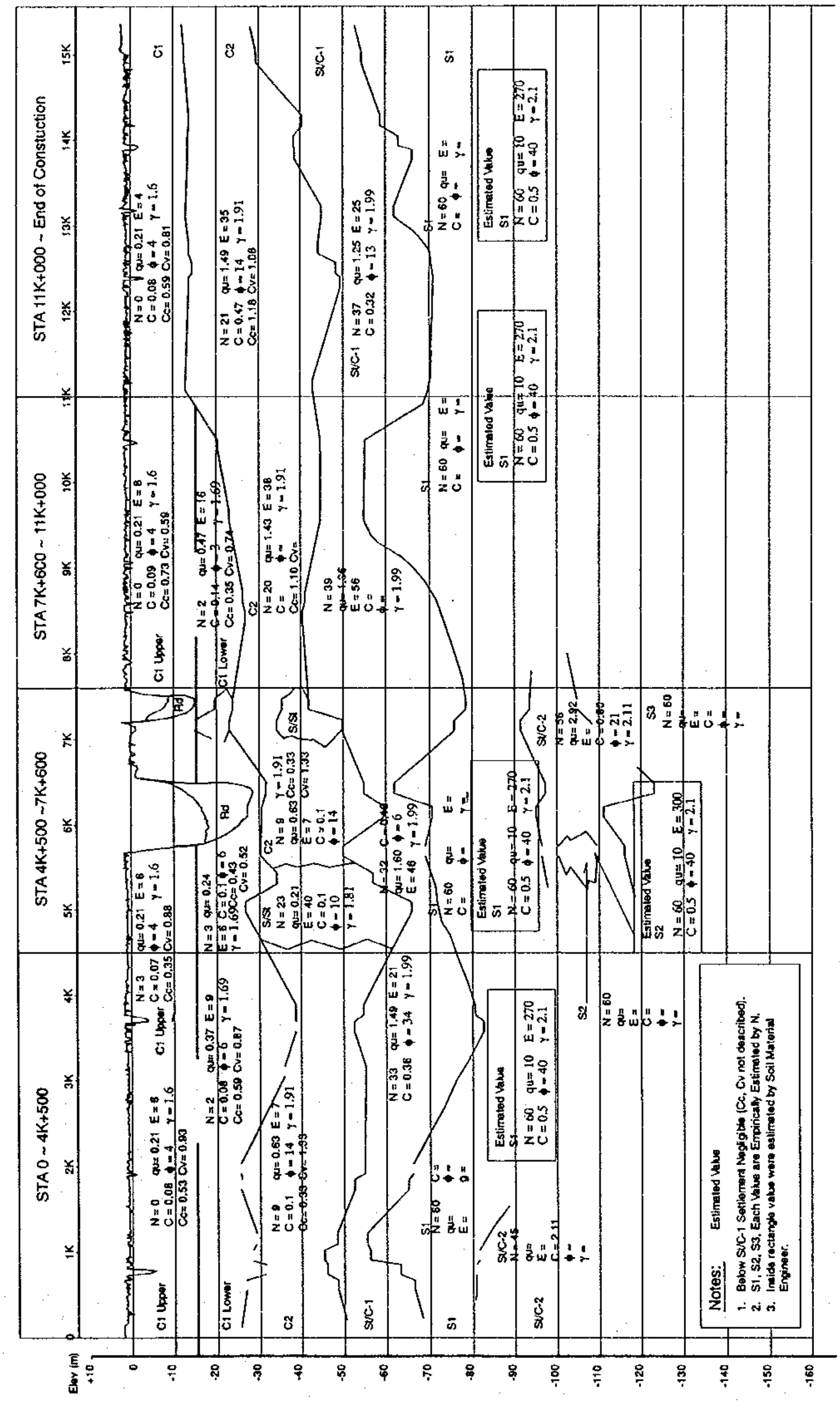
$$E = \frac{E_O}{1 + \frac{(\gamma \cdot l \cdot \cos\alpha)^2 \cdot (\sigma_1 + \sigma_2)}{24 \sigma_1^2 \cdot \sigma_2^2}}$$

Here E : Elastic modulus of Stay Cable In the case that sag is considered
Eo : Elastic modulus of Stay Cable
γ : Unit weight of Stay Cable
l : Stay Cable length
α : Inclining Angle
σ : Tensile stress of Stay Cable

Stay stresses shall be limited to 0.40 f_p under maximum service loads. This figure may be increased to 0.60 f_p during construction or during stay exchange/removal.
The steel properties are given in the table below

Material	Nom.Id	Area	Guaranteed Ultimate Tensile Strength f_p	Guaranteed Ultimate Force P_B	Service Limit Force
	Mm	Mm^2	MPa	kN	kN
Strand	15.2	140	1862	261	104

1.5 Geo-technical Condition



Chapter 2

MAJOR LOADS

2. Major Load

2.1 Dead Load

Force transferred from superstructure was analyzed in the superstructure design, and the effect of creep and shrinkage in the construction stage was considered as a part of Dead Load.

Permanent loads shall be calculated in accordance with Clause 3.5 of AASHTO LRFD. Dead loads shall include the weight of the concrete, steel reinforcement, prestressing tendons, cable stays, steelworks and any other embedded components, based on the following unit weights.

- Concrete (Reinforced) : 2500 kg/m^3
  (Unreinforced): 2300 kg/m^3
- Steel work 7850 kg/m^3
- Asphalt 2300 kg/m^3
- Cable Stays

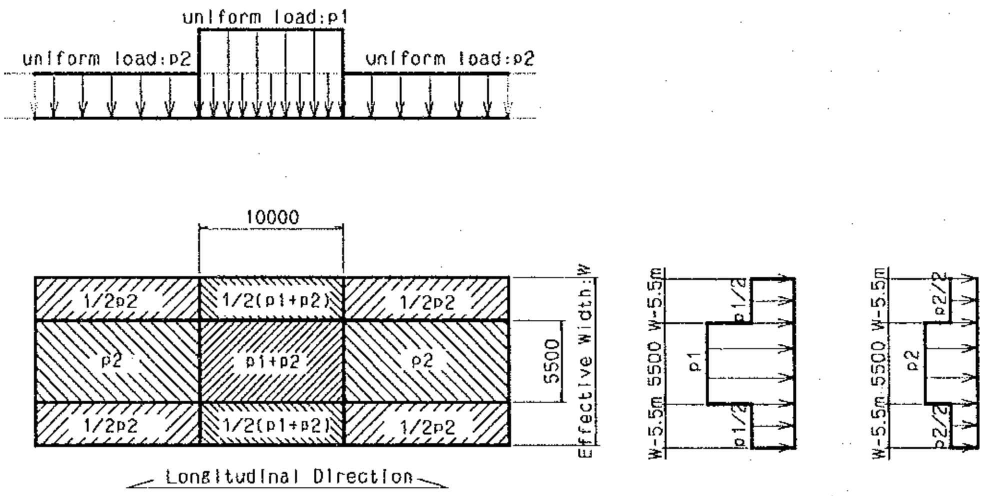
The total superimposed dead load allowance (DW) of 62 kN/m is assumed, with the following breakdown:

- Carriageway asphalt surfacing 36 kN/m (thickness 75 mm, no allowance for future overlay)
- Concrete median barrier 8 kN/m
- Steel pedestrian barrier 1 kN/m per side
- Concrete edge barriers 5 kN/m per side
- Possible future services 6 kN/m

2.2 Live Load

The design traffic load of the principal part of the bridge applies the B-load. (Japanese Standard) As for the details of the B load refer to Design Criteria

B-Live Load for Girder Design



Main loading (loading width : max. 5.5m)						Sub-loading
p1 - uniform load			p2 uniform load			
Loading length D	Strength (kgf/cm^2)		Strength (kgf/cm^2)			
(m)	for M	for S	L≦80	80<L≦130	L>130	
10	1,000	1200	350	430-L	300	50% of main-loadings

Dynamic Load Allowance

Impact coefficient calculated in accordance with AASHTO and Japanese Standard. Main Bridge applies the standard of Japan and other bridges apply AASHTO.

AASHTO -Approach viaduct and other bridges of approach road section

Impact coefficient : I=0.33

Japanese Standard - Main Bridge

$$I = 20/(L+50)$$

I: impact coefficient

L: length in meter of the portion of the span that is loaded to produce the maximum stress in the member.

Impact coefficient for middle span : 0.033

Impact coefficient for side span

P14(P15)~Northern Pylon(Southern Pylon) : 0.111

P12~P13, P13~P14, P15~P16, P16~P17 : 0.167

2.3 Thermal Effect

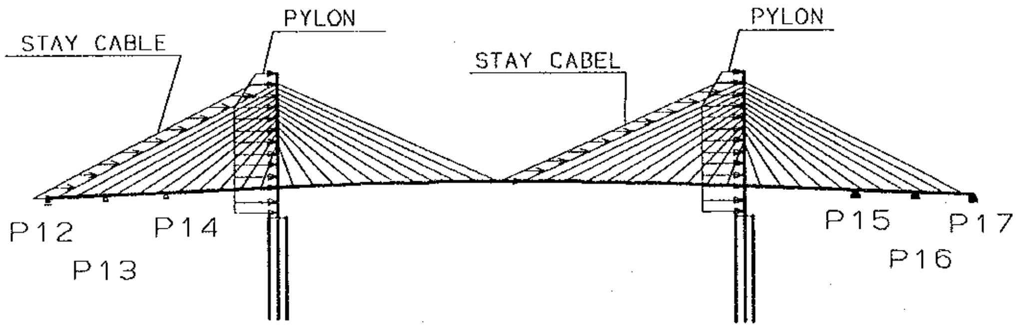
Thermal Rise and Down is "±15°C"

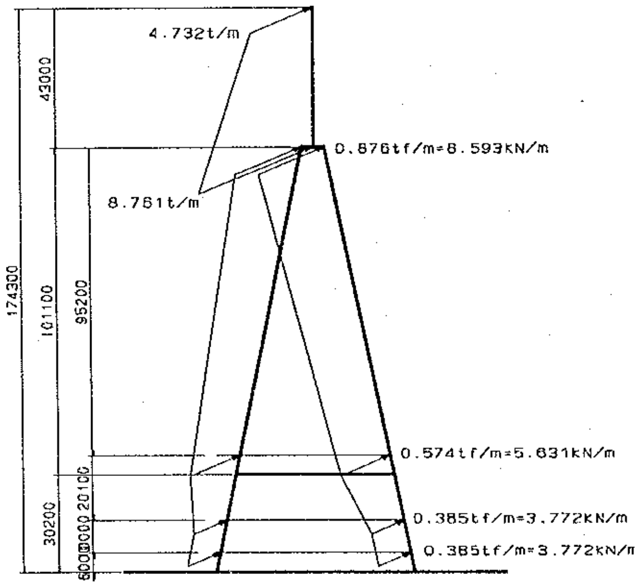
Differential Temperature is "5°C"

2.4 Wind Load

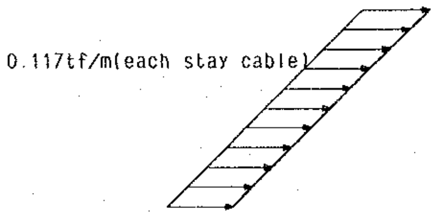
2.4.1 Static analysis

Longitudinal Direction





Wind Load for Pylon



Wind Load for Stay Cable

Calculate of Static Wind Pressure

AASHTO LRFD Section 3, Article 3.8

V0=	13.2	km/h
Z0=	70.0	mm
Vb=	160.0	km/h
V10=	160.0	km/h

Pb= 0.0024

VDZ	Z	2.5*V0*(V10/Vb)	In (Z/Z0)	VDZ	Pd(MPa)	MPa	B(m)	P(kN/m)
Z1	10,000	33.00	4.9618	163.7	0.0025	0.0038	10.000	37.703
Z2	30,100	33.00	6.0638	200.1	0.0038	0.0056	10.000	56.309
Z3	125,300	33.00	7.4900	247.2	0.0057	0.0086	10.000	85.911
Z4	168,300	33.00	7.7850	256.9	0.0062	0.0093	5.000	46.406
Z5	87,500	33.00	7.1309	235.3	0.0052		0.440	2.284

Pb= 0.0036

VDZ	Z	2.5*V0*(V10/Vb)	In (Z/Z0)	VDZ	Pd(MPa)	MPa	B(m)	P(kN/m)
Z1	10,000	33.00	4.9618	163.7	0.0038	0.0057	8.000	45.244
Z2	30,100	33.00	6.0638	200.1	0.0056	0.0084	10.000	84.464
Z3	125,300	33.00	7.4900	247.2	0.0086	0.0129	10.000	128.867
Z4	168,300	33.00	7.7850	256.9	0.0093	0.0139	5.000	69.610
Z5	87,500	33.00	7.1309	235.3	0.0078		0.440	3.426

2.5 Vessel Collision Force

The vessel collision force of the ship is hypothesizing of 10000DWT collides with the foundation of Pylon from navigable line. The collision of the ship of 5000DWT is hypothesized to supplementary piers.
The impact load of 500DWT causes to be acted to the bridge of the tributary in consideration of the navigation of the ship of the present condition.

Ship Collision Force on Pier

The head-on ship collision impact force on a pier shall be taken as:

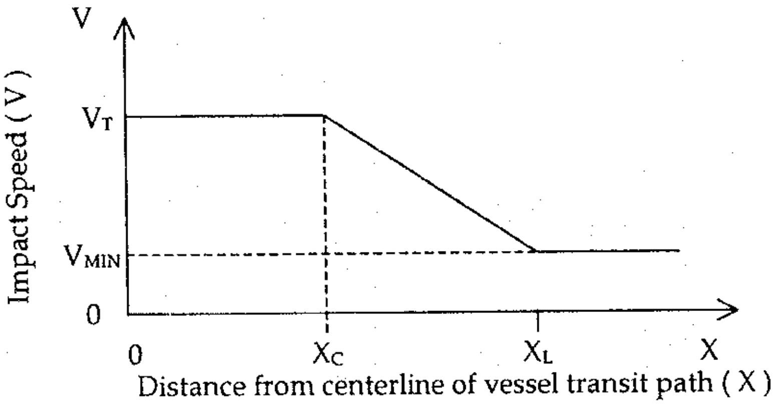
$$P_S = 1.2 \times 10^5 V \sqrt{DWT}$$

where:

P_S = equivalent static vessel impact force (N)

DWT = dead weight tonnage of vessel (Mg)

V = vessel impact velocity (m/s)



Application of Impact Forces

Substructure Design

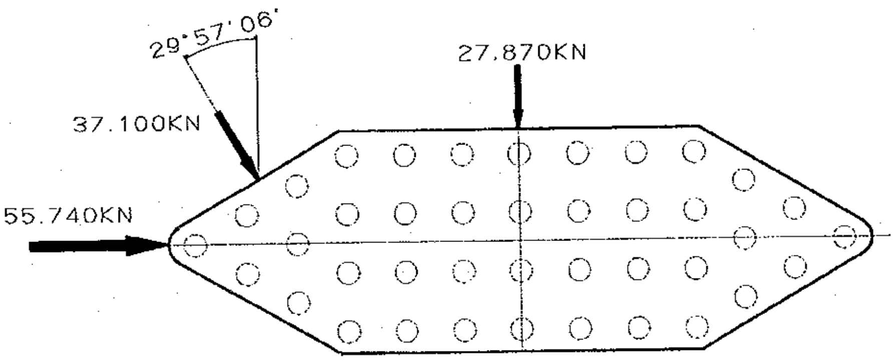
For substructure design, equivalent static forces, parallel and normal to the centerline of the navigable channel, shall be applied separately as following:

- 100 percent of the design impact force in a direction parallel to the alignment of the centerline of the navigable channel.
- 50 percent of the design impact force in the direction normal to the direction of the centerline of the channel.
- For overall stability, the design impact force is applied as a concentrated force in the substructure at the mean high water level for the waterway.

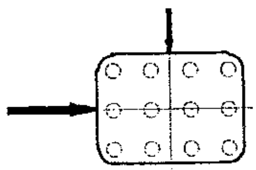
Ship Impact Force for Substructure

unit : kN

Substructure	Longitudinal	Transverse
Southern Pylon	27,870	55,470
Pier P15	11,520	23,040
Pier P16	8,690	17,380
Pier P17	8,490	16,970
Pier P36	3,250	6,500
Pier P37	4,370	8,750
Pier P38	6,630	13,260
Pier P39	6,630	13,260
Pier P40	4,370	8,750
Pier P41	3,250	6,500



SOUTHERN PYLON



PIER

2. 6 Seismic Force

At determination of elastic seismic response coefficient which is resulting from formula in accordance with specification of AASHTO LRFD (Article 3.10) as follows. Acceleration coefficient "A" shall be taken in proposal of VIET NAM NATIONAL CENTER FOR NATURAL SCIENCE AND TECHNOROGY INSTITUTE OF GEOPHYSICS.

2.6.1 Examination of Seismic Coefficient

(1) Formula for elastic seismic response coefficient

Type	Formula
$T_m > 4.0$	C_{sm}=3AS / $T^{4/3}$
$0.3 < T_m < 4.0$	C_{sm}=1.2AS / $T^{2/3} \geqq 2.5A$
$T_m < 0.3$	C_{sm}=A $(0.8+4.0\,T_m)$

T_m ; Period of vibration (sec)
A ; Acceleration coefficient
S ; Site coefficient

(2) Soil condition of construction area

In accordance with the boring log, classification of soil condition for Main bridge and Approach bridges are taken as;

1) Main bridge S=2.0 (Soil profile type IV)
2) Approach bridge S=2.0 (Soil profile type IV)

(3) Elastic Seismic Response Coefficient

1) Main Bridge

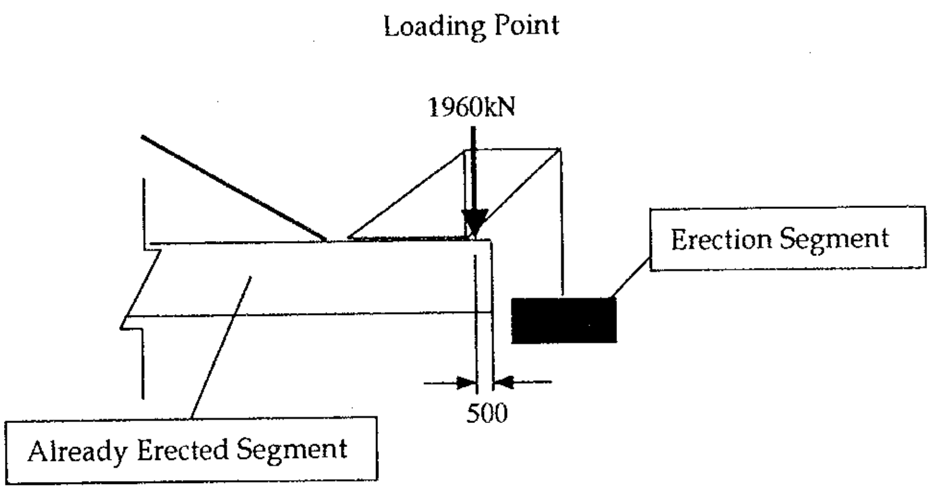
Elastic seismic response coefficient for main bridge, shall be taken as;
C_{sm} =3*0.12*2.0 / $4.00^{4/3}$ =0.113
where ; A =0.12
S =2.0
T_m =4.00 (sec) ; Mode 3

2) Approach Bridge

	A	T(sec)	Csm
Approach Viaduct	0.06	0.5	0.150*
		1.0	0.144
		1.5	0.110
Approach Road Bridge	0.05	0.5	0.125*
		1.0	0.120
		1.5	0.092

2.7 Erection Equipment Weight for Cable Stayed Bridge

Erection Nose Weight : 1960 kN (200tf)



Chapter 3

DESIGN SUMMARY OF MAIN BRIDGE (CABLE STAYED BRIDGE)

3. Design Summary of Main Bridge (Cable Stayed Bridge)

3.1 Structural Feature

As for a main bridge, main span length is 550 m, total bridge length is 1090m.main span is the hybrid cable stayed bridge that the steel girder and P.C connected. The Pylon makes the concrete of box section.

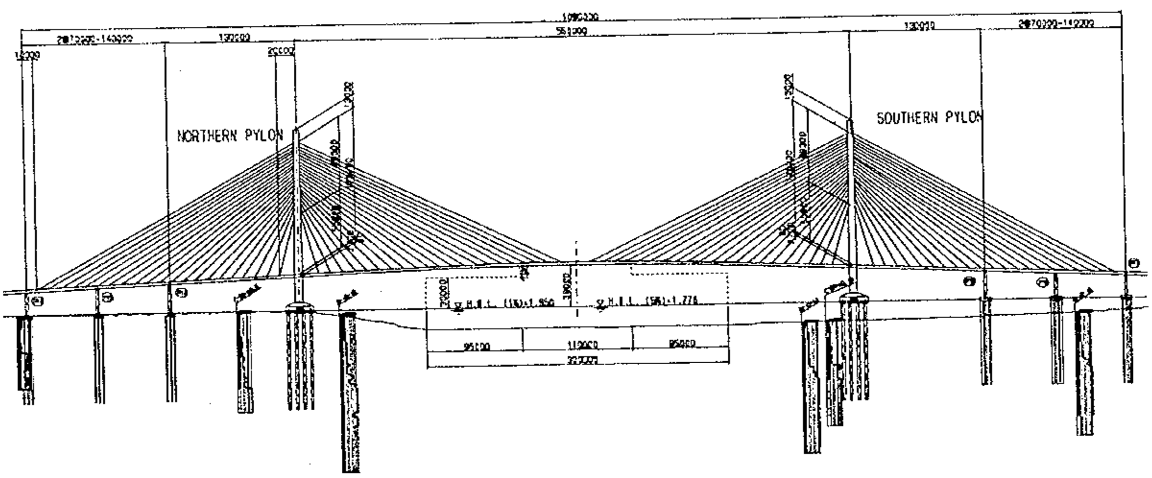
The arrangement of the pier of the side span made the interval of a minimum pier 70 m, to avoid hindering the flow of the water of the river with the pier, that there are the traffic of many ships, that the width of the river is wide.

The stiffening girder, that the width of the road is wide the stability by wind in consideration of the box girder type.

As for the type of the structure of the pylon transformation performance adopts a good A-type, because the scale of the bridge is big.

It is as the details following of structure.

- The length of the concrete segment of the stiffening girder makes minimum length 4 m, to hold down the occurrence of the twist.
- The construction method of stiffening girder a makes a balance cantilever method.
- Stay cable uses parallel strand stay cable that was plated by zinc.
- The foundation of the main pier is the composite pile of a steel pipe and concrete.
- Elastomeric Bearing supports the force of vertical and longitudinal horizontal direction to flexibility.

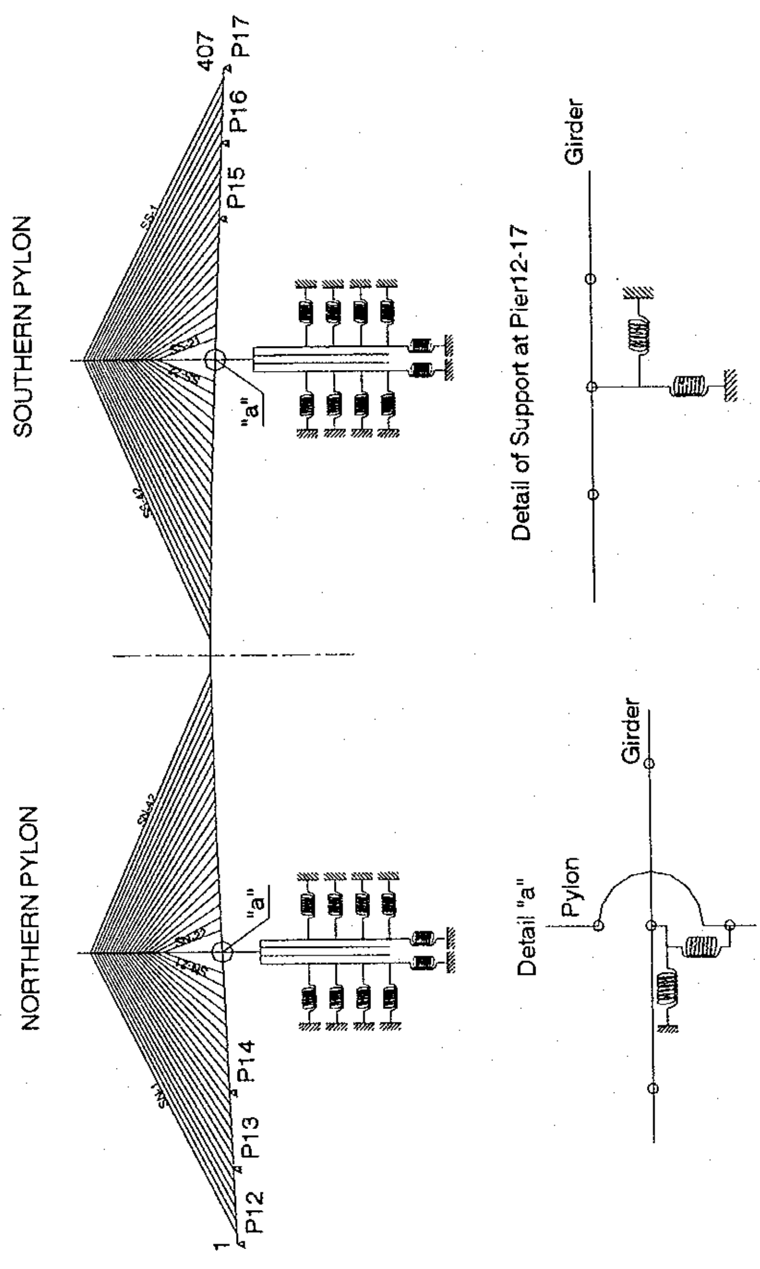


GENERAL VIEW OF MAIN BRIDGE

3.2 Calculation Method

3.2.1 2-D Frame Analysis

The design of the longitudinal direction of the girder makes the 2-D Frame Analysis by Infinitesimal Deformation Theory. The software that used it for calculation is "CONST". 2-D Frame Analysis shall be calculated sectional force, displacement, stress of complete structure and erection steps.



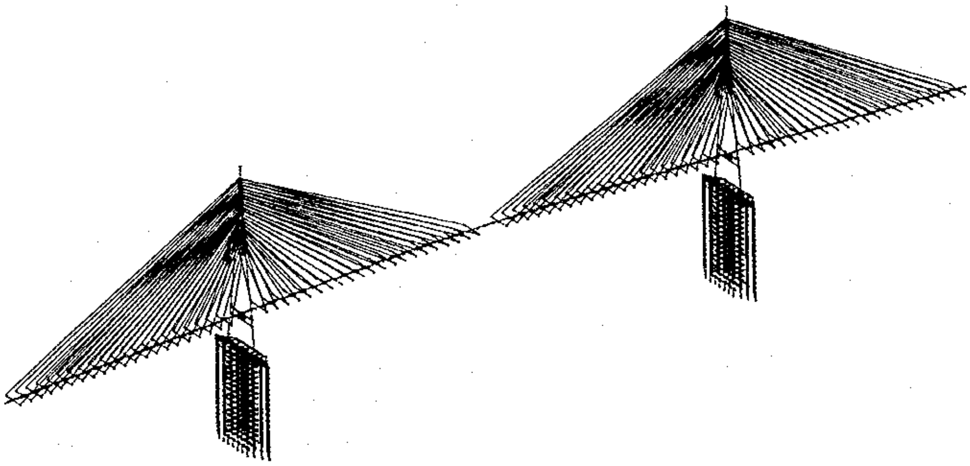
3.2.2 Space Frame Analysis

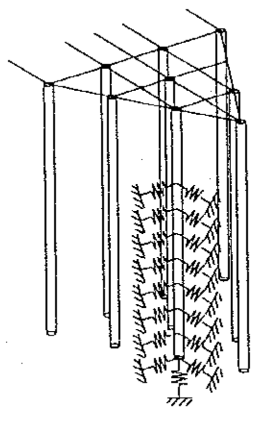
The purpose of the analysis by space frame is as shown below. The software that used it for the space frame analysis is "fancy".

- Design of the section of the transverse direction of pylon.
- The fluctuation of stress of stay cable by life load is confirmed.
- The section design of transverse direction of a main girder.
- Transformation of a main girder is confirmed.

Calculation Model

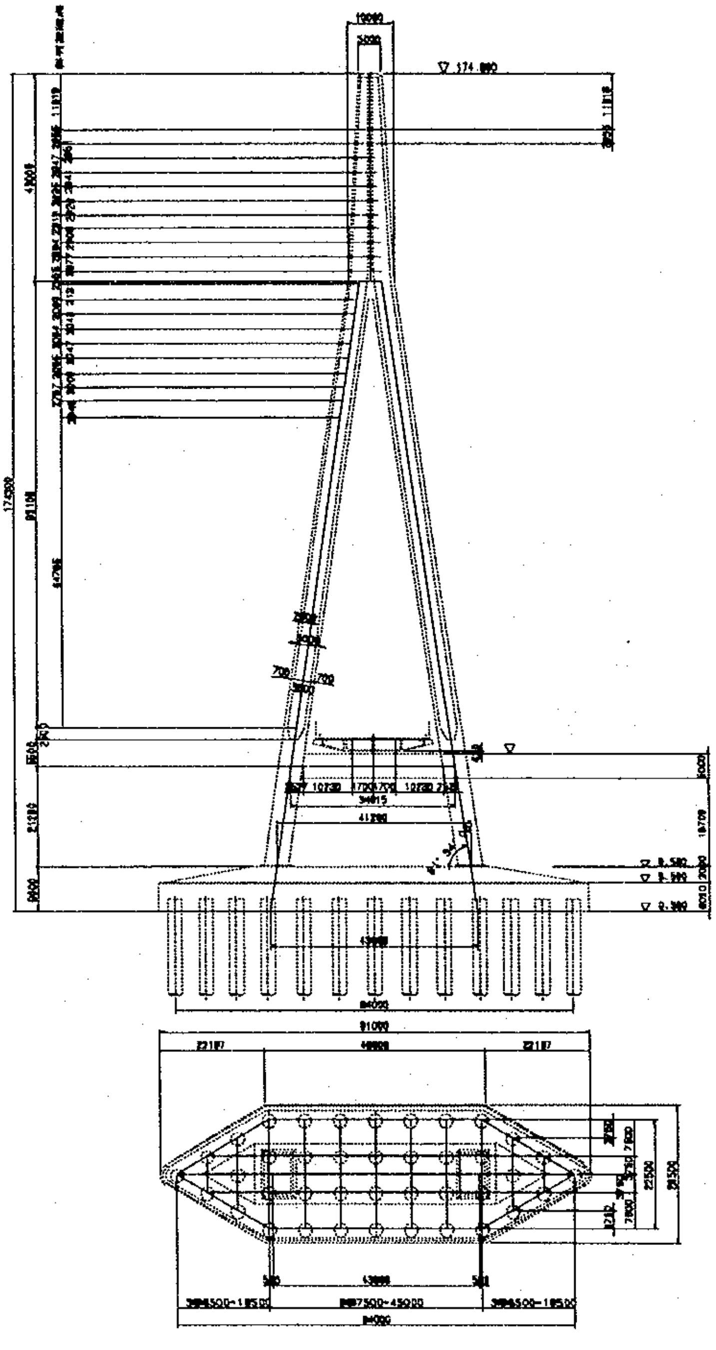
GROVAL MODEL





FOUNDATION MODEL

PYLON MODEL



3.3 Construction Sequence

Support condition of P13,P14,P15,P16 :

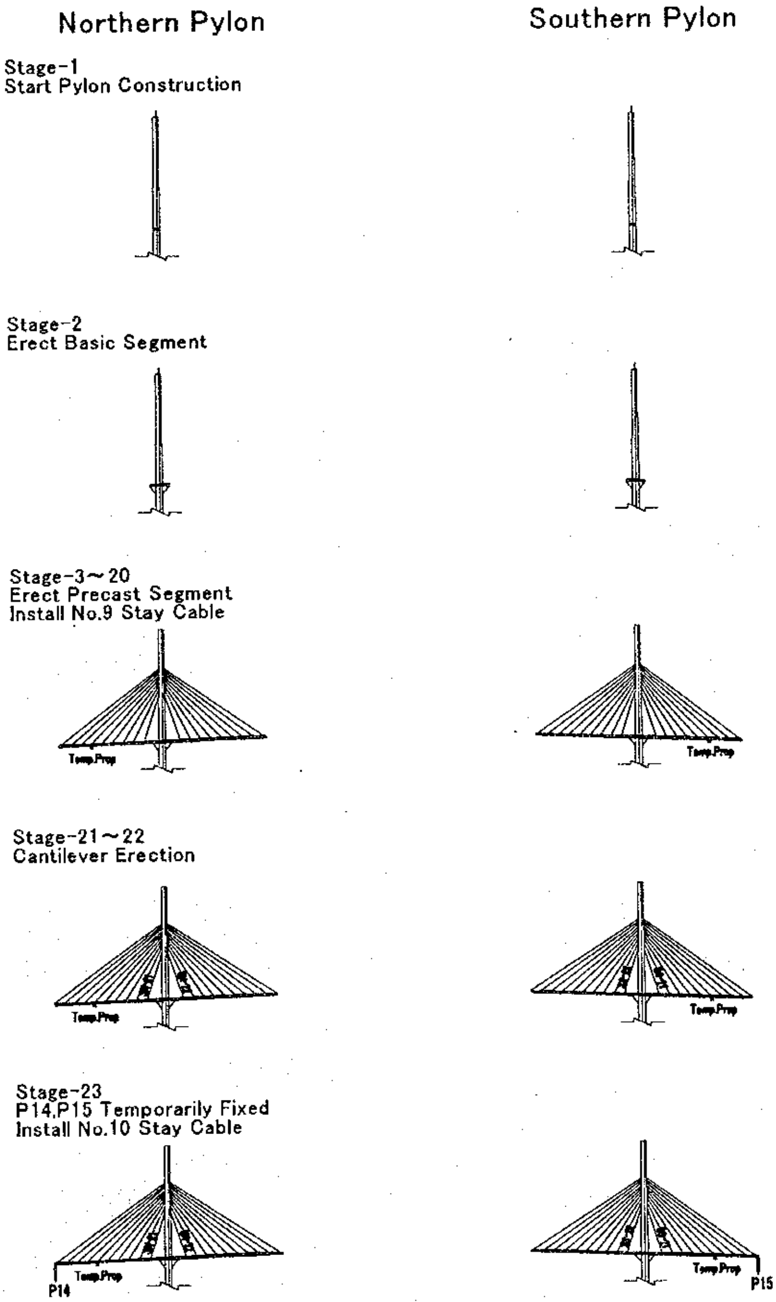
- During Construction

  Support Element will be fixed for Vertical and Horizontal direction.

- After Completion of Structure

  Elastomeric Support

  Support condition of P12,P17 : Elastomeric Support

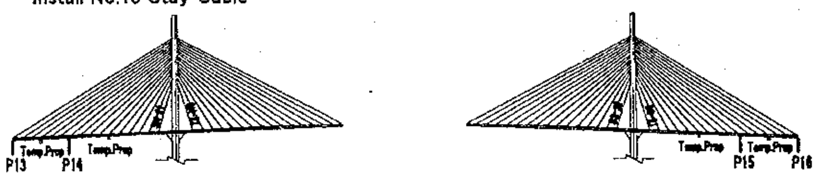


Stage-24～28
Erect Precast Segment
Install No.12 Stay Cable

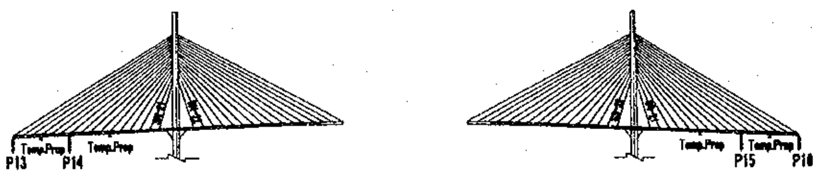
Stage-29
Set Prop
Install No.13 Stay Cable

Stage-30～34
Erect Precast Segment

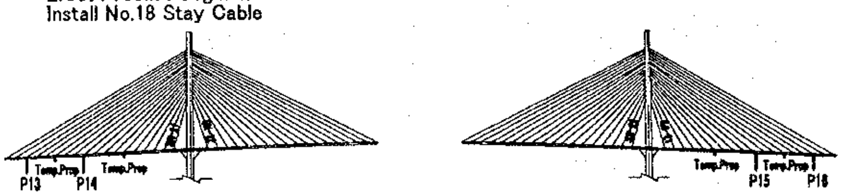
Stage-35
P13,P16 Temporarily Fixed
Install No.15 Stay Cable



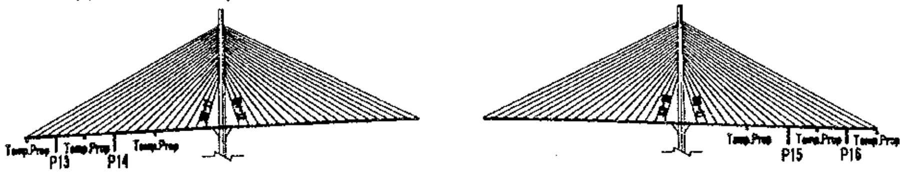
Stage-36
Install No.16 Stay Cable



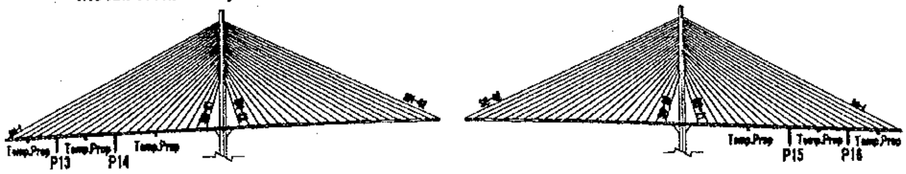
Stage-37～42
Erect Precast Segment
Install No.18 Stay Cable



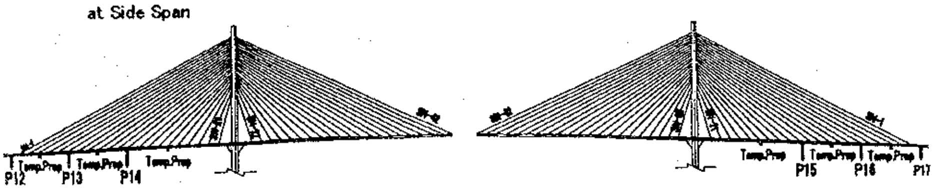
Stage-43
Set Prop
Install No.19 Stay Cable



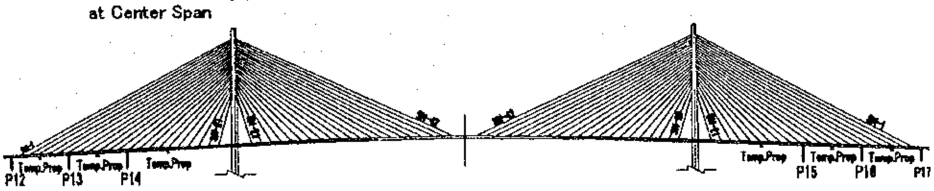
Stage-44～47
Erect Precast Segment
Install No.21 Stay Cable



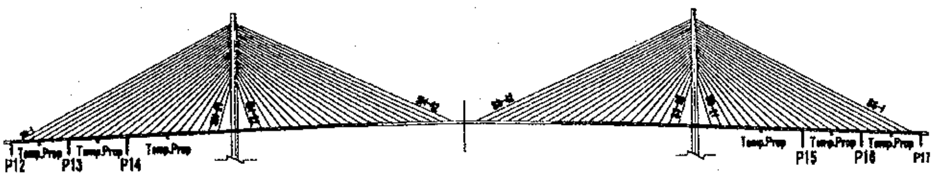
Stage-48
Erect Closure Segment
at Side Span



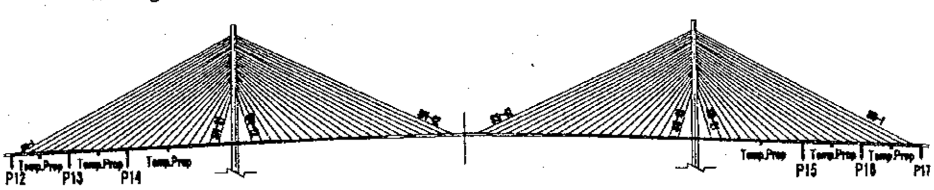
Stage-49
Erect Closure Segment
at Center Span



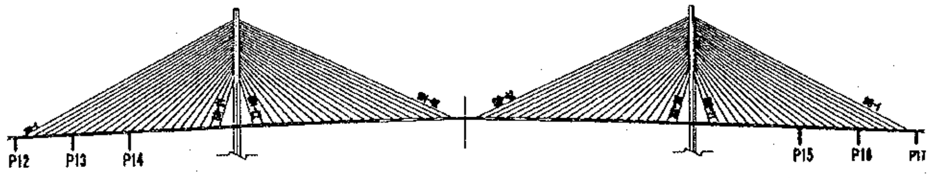
Stage-50
Release Temporary Support
at Pylon



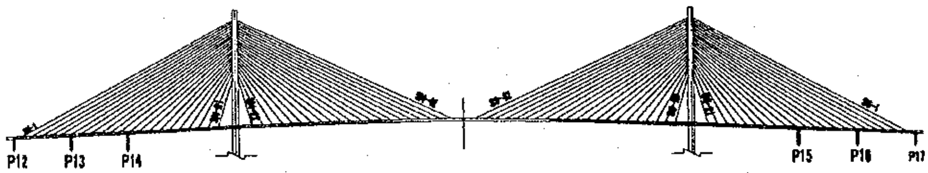
Stage-51
Wearing Surface and Utilities



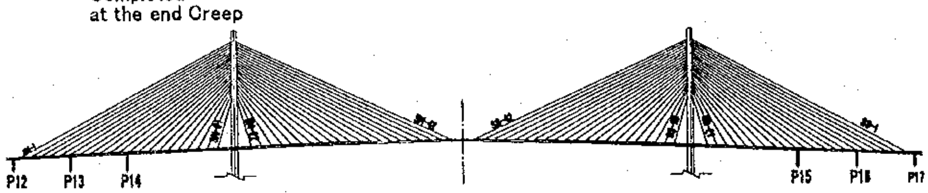
Stage-52
Release Temporary Support
at Pier



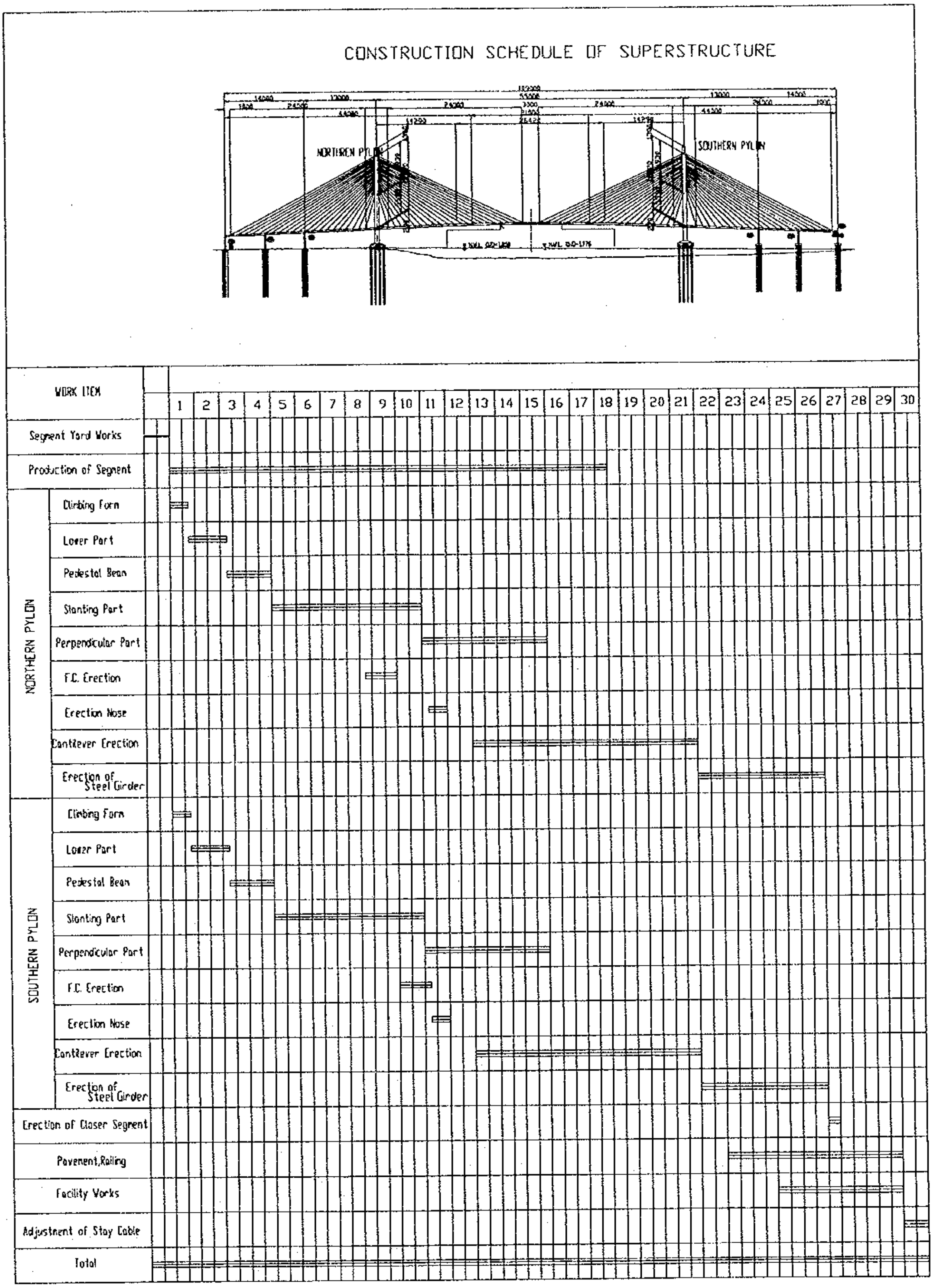
Stage-53
Adjustment Stay Cables



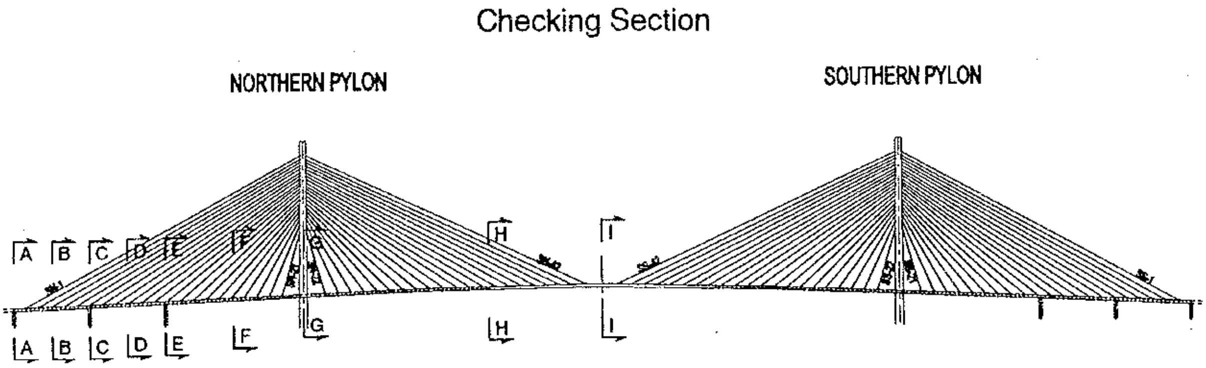
Structural Components
Completed~
at the end Creep



3.4 Construction Schedule



3.5 Overall Structure Analysis



3.5.1 Result of 2D Analysis

Table Sectional Force after the Construction Completed

Section Name	SECTION-A			SECTION-B						SECTION-C					
				Left			Right			Left			Right		
	1 - 2			16 - 15			16 - 17			30 - 29			30 - 31		
	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)
*** Axial Force , Maximum ***															
DC+DW	-216	5285	0	-31251	-31	28983	-31251	-31	28983	-45903	-13128	-175708	-54959	8937	-175708
DC+DW+L(+)	-62	4743	0	-30883	-169	27526	-30883	-169	27526	-45264	-13956	-186148	-54173	9763	-181657
DC+DW+L(-)	-450	7914	0	-35179	340	32070	-35174	340	32070	-52098	-12869	-169447	-62359	8648	-173902
DC+DW+T MAX	193	5224	0	-31052	11	28383	-31052	11	28383	-45771	-13050	-174164	-54477	8871	-174164
DC+DW+T MIN	-687	5601	0	-31525	186	38437	-31525	186	38437	-46125	-12937	-159147	-55576	8902	-159147
DC+DW+L+T MAX	347	4681	0	-30684	-126	26926	-30684	-126	26926	-45131	-13878	-184604	-53692	9697	-180113
DC+DW+L+T MIN	-920	8229	0	-35452	558	41523	-35447	558	41523	-52320	-12678	-152886	-62977	8613	-157341
DC+DW+EQ	6178	4342	0	-30841	628	19385	-30841	628	19385	-49220	-11950	-151946	-52184	7962	-151946
DC+DW-EQ	-6612	6227	0	-31662	-692	38582	-31662	-692	38582	-42586	-14306	-199470	-57733	9912	-199470
*** Shear Force , Maximum ***															
DC+DW	-216	5285	0	-31251	-31	28983	-31251	-31	28983	-45903	-13128	-175708	-54959	8937	-175708
DC+DW+L(+)	-325	8717	0	-34473	1481	42835	-34456	1481	42835	-51890	-11279	-150786	-55111	12931	-210171
DC+DW+L(-)	-197	3787	0	-31266	-1764	52583	-31261	-1764	52583	-45602	-17327	-209397	-61670	7312	-149382
DC+DW+T MAX	-687	5601	0	-31125	272	37236	-31125	272	37236	-45860	-12780	-156059	-55440	9002	-177252
DC+DW+T MIN	193	5224	0	-31451	-74	29583	-31451	-74	29583	-46035	-13206	-177252	-54613	8771	-156059
DC+DW+L+T MAX	-795	9033	0	-34347	1784	51088	-34330	1785	51088	-51847	-10931	-131137	-55592	12996	-211715
DC+DW+L+T MIN	212	3725	0	-31465	-1807	53183	-31461	-1807	53183	-45734	-17405	-210941	-61324	7146	-129733
DC+DW+EQ	6178	4342	0	-30841	628	19385	-30841	628	19385	-49220	-11950	-151946	-52184	7962	-151946
DC+DW-EQ	-6612	6227	0	-31662	-692	38582	-31662	-692	38582	-42586	-14306	-199470	-57733	9912	-199470
*** Bending Moment , Maximum ***															
DC+DW	-216	5285	0	-31251	-31	28983	-31251	-31	28983	-45903	-13128	-175708	-54959	8937	-175708
DC+DW+L(+)	-216	5285	0	-31262	-442	73766	-31241	-441	73766	-51641	-11317	-149362	-61633	7314	-149362
DC+DW+L(-)	-216	5285	0	-34350	117	2674	-34350	117	2674	-45968	-16731	-218543	-55246	11457	-218543
DC+DW+T MAX	193	5224	0	-31525	186	38437	-31525	186	38437	-45860	-12780	-156059	-54613	8771	-156059
DC+DW+T MIN	-687	5601	0	-31052	11	28383	-31052	11	28383	-46035	-13206	-177252	-55440	9002	-177252
DC+DW+L+T MAX	193	5224	0	-31535	-223	83219	-31514	-223	83219	-51598	-10969	-129713	-61287	7148	-129713
DC+DW+L+T MIN	-687	5601	0	-34150	160	2074	-34150	160	2074	-46100	-16809	-220087	-55728	11523	-220087
DC+DW+EQ	6178	4342	0	-30841	628	19385	-30841	628	19385	-49220	-11950	-151946	-52184	7962	-151946
DC+DW-EQ	-6612	6227	0	-31662	-692	38582	-31662	-692	38582	-42586	-14306	-199470	-57733	9912	-199470

NOTE
DC+DW: Dead Load At the end of Creep
T: Thermal Effect
L: Live Load with Impact
{(+): Max , (-): Min}
EQ: Seismic Force

Table Sectional Force after the Construction Completed

Section Name	SECTION-D						SECTION-E						SECTION-F					
	Left			Right			Left			Right			Left			Right		
	45 - 44			45 - 46			60 - 59			60 - 61			85 - 84			85 - 86		
	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)	N(kN)	S(kN)	M(kNm)
*** Axial Force , Maximum ***																		
DC+DW	-69493	-4158	-101071	-76735	-174	-101071	-87418	-13348	-316225	-88454	12334	-316225	-122385	3778	85103	-122385	3778	85103
DC+DW+L(+)	-68320	-5103	-102569	-75349	-846	-110485	-85510	-14438	-349795	-86546	14653	-348985	-121307	4108	106147	-121303	4108	106147
DC+DW+L(-)	-79238	-3455	-97980	-87467	744	-90138	-100121	-12854	-286554	-101191	9866	-287030	-138680	4085	64266	-138680	4085	64266
DC+DW+T MAX	-68987	-4238	-102005	-76197	-273	-102005	-86769	-13522	-321767	-87518	12638	-321767	-121095	3780	88378	-121095	3780	88378
DC+DW+T MIN	-70190	-4147	-85094	-77487	-128	-85094	-88313	-13207	-297102	-89669	12013	-297102	-123989	3789	95265	-123989	3789	95265
DC+DW+L+T MAX	-67815	-5182	-103503	-74811	-946	-111420	-84860	-14612	-355337	-85610	14957	-354527	-120017	4110	109422	-120012	4110	109422
DC+DW+L+T MIN	-79935	-3443	-82004	-88218	790	-74161	-101015	-12713	-267431	-102406	9545	-267907	-140283	4096	74428	-140283	4096	74428
DC+DW+EQ	-69197	-5343	-114947	-76086	-1619	-114947	-87764	-15906	-396178	-82660	16893	-396178	-116388	3875	141236	-116388	3875	141236
DC+DW-EQ	-69788	-2974	-87195	-77384	1271	-87195	-87073	-10790	-236272	-94247	7775	-236272	-128383	3681	28970	-128383	3681	28970
*** Shear Force , Maximum ***																		
DC+DW	-69493	-4158	-101071	-76735	-174	-101071	-87418	-13348	-316225	-88454	12334	-316225	-122385	3778	85103	-122385	3778	85103
DC+DW+L(+)	-73649	-2597	-83585	-85925	1901	-84964	-99756	-11061	-268789	-87390	16444	-360820	-134830	5395	90753	-134814	5396	90753
DC+DW+L(-)	-72882	-5909	-86061	-75893	-1915	-84682	-86274	-17663	-360351	-100674	9252	-268742	-122801	2451	105337	-122796	2451	105337
DC+DW+T MAX	-69998	-4079	-100136	-77273	-74	-100136	-88068	-13173	-310683	-87518	12638	-321767	-121408	3793	101815	-121408	3793	101815
DC+DW+T MIN	-69179	-4306	-86963	-76411	-327	-86963	-87014	-13556	-308186	-89669	12013	-297102	-123676	3776	81829	-123676	3776	81829
DC+DW+L+T MAX	-74154	-2517	-82650	-86463	2001	-84029	-100405	-10887	-263247	-86454	16748	-366362	-133853	5411	107465	-133837	5411	107465
DC+DW+L+T MIN	-72568	-6056	-71953	-75569	-2069	-70575	-85870	-17871	-352313	-101889	8931	-249620	-124091	2448	102063	-124087	2449	102063
DC+DW+EQ	-69197	-5343	-114947	-76086	-1619	-114947	-87764	-15906	-396178	-82660	16893	-396178	-116388	3875	141236	-116388	3875	141236
DC+DW-EQ	-69788	-2974	-87195	-77384	1271	-87195	-87073	-10790	-236272	-94247	7775	-236272	-128383	3681	28970	-128383	3681	28970
*** Bending Moment , Maximum ***																		
DC+DW	-69493	-4158	-101071	-76735	-174	-101071	-87418	-13348	-316225	-88454	12334	-316225	-122385	3778	85103	-122385	3778	85103
DC+DW+L(+)	-70673	-4240	-66844	-78197	-62	-66844	-99634	-11065	-268734	-100626	9253	-268734	-121476	3795	117934	-121456	3796	117934
DC+DW+L(-)	-75604	-4448	-118633	-83262	-212	-118633	-85870	-16254	-369507	-87013	15719	-369507	-138215	4073	63670	-138215	4073	63670
DC+DW+T MAX	-70190	-4147	-85094	-77487	-128	-85094	-88313	-13207	-297102	-89669	12013	-297102	-121408	3793	101815	-121408	3793	101815
DC+DW+T MIN	-68987	-4238	-102005	-76197	-273	-102005	-86769	-13522	-321767	-87518	12638	-321767	-123676	3776	81829	-123676	3776	81829
DC+DW+L+T MAX	-71370	-4228	-50868	-78948	-16	-50868	-100528	-10924	-249612	-101840	8932	-249612	-120499	3811	134645	-120479	3811	134645
DC+DW+L+T MIN	-75099	-4528	-119567	-82724	-312	-119567	-85221	-16429	-375049	-86077	16023	-375049	-139506	4071	60395	-139506	4071	60395
DC+DW+EQ	-69197	-5343	-114947	-76086	-1619	-114947	-87764	-15906	-396178	-82660	16893	-396178	-116388	3875	141236	-116388	3875	141236
DC+DW-EQ	-69788	-2974	-87195	-77384	1271	-87195	-87073	-10790	-236272	-94247	7775	-236272	-128383	3681	28970	-128383	3681	28970

NOTE

DC+DW Dead Load At the end of Creep

T: Thermal Effect

L: Live Load with Impact
((+) : Max , (-) : Min)

EQ: Seismic Force

Table Sectional Force after the Construction Completed

Section Name	SECTION-G						SECTION-H						SECTION-I		
	Left			Right			Left			Right					
	109 - 108			109 - 110			169 - 168			169 - 170			204 - 203		
	N(KN)	S(KN)	M(KNM	N(KN)	S(KN)	M(KNM	N(KN)	S(KN)	M(KNM	N(KN)	S(KN)	M(KNM	N(KN)	S(KN)	M(KNM)
*** Axial Force , Maximum ***				**											
DC+DW	-133459	-13973	-122656	134599	11745	-122656	-39636	614	-3893	-39636	646	-3893	2734	1	65711
DC+DW+L(+)	-133067	-16544	-132714	133910	11913	-129753	-38325	641	-7009	-38324	671	-7009	4239	-10	61934
DC+DW+L(-)	-149974	-14363	-145440	151764	13034	-143479	-49933	1251	-19310	-49929	1291	-19309	1367	85	109011
DC+DW+T MAX	-132159	-13973	-120020	132529	11595	-120020	-37452	631	-4543	-37452	661	-4543	4998	1	66251
DC+DW+T MIN	-135099	-13906	-109158	137060	11847	-109158	-42354	461	2355	-42354	495	2355	171	0	64435
DC+DW+L+T MAX	-131767	-16545	-130077	131840	11762	-127117	-36141	657	-7659	-36141	686	-7659	6503	-10	62473
DC+DW+L+T MIN	-151615	-14297	-131941	154225	13136	-129980	-52651	1098	-13061	-52647	1140	-13061	1195	84	107734
DC+DW+EQ	-131558	-15675	-124794	117238	10627	-124794	-33376	1016	-2839	-33375	1042	-2839	3903	-874	66545
DC+DW-EQ	-135360	-12271	-120518	151960	12863	-120518	-45897	213	-4948	-45896	250	-4948	1564	877	64878
*** Shear Force , Maximum ***				**											
DC+DW	-133459	-13973	-122656	134599	11745	-122656	-39636	614	-3893	-39636	646	-3893	2734	1	65711
DC+DW+L(+)	-147876	-13633	-122314	142334	14949	-154121	-45030	2648	2105	-45054	2684	2013	2629	1639	93473
DC+DW+L(-)	-134647	-17333	-153787	142622	11448	-122599	-43028	-424	6276	-42990	-390	6368	2645	-1637	93484
DC+DW+T MAX	-135099	-13906	-109158	136669	11896	-125293	-37452	631	-4543	-37452	661	-4543	4998	1	66251
DC+DW+T MIN	-132159	-13973	-120020	132920	11546	-103885	-42354	461	2355	-42354	495	2355	171	0	64435
DC+DW+L+T MAX	-149517	-13566	-108816	144404	15099	-156757	-42847	2664	1455	-42871	2699	1363	4894	1640	94013
DC+DW+L+T MIN	-133347	-17333	-151151	140944	11250	-103827	-45746	-577	12525	-45709	-540	12617	82	-1637	92207
DC+DW+EQ	-131558	-15675	-124794	117238	10627	-124794	-33376	1016	-2839	-33375	1042	-2839	3903	-874	66545
DC+DW-EQ	-135360	-12271	-120518	151960	12863	-120518	-45897	213	-4948	-45896	250	-4948	1564	877	64878
*** Bending Moment , Maximum ***				**											
DC+DW	-133459	-13973	-122656	134599	11745	-122656	-39636	614	-3893	-39636	646	-3893	2734	1	65711
DC+DW+L(+)	-146505	-13717	-119632	148237	11621	-119632	-41937	1018	26119	-41925	1052	26119	1946	0	110681
DC+DW+L(-)	-136170	-16464	-162554	137167	13596	-162554	-47295	949	-36854	-47294	987	-36854	3493	75	58917
DC+DW+T MAX	-132499	-13907	-103885	132920	11546	-103885	-42354	461	2355	-42354	495	2355	4998	1	66251
DC+DW+T MIN	-134759	-13972	-125293	136669	11896	-125293	-37452	631	-4543	-37452	661	-4543	171	0	64435
DC+DW+L+T MAX	-145545	-13651	-100860	146559	11422	-100860	-44655	865	32368	-44643	901	32368	4211	1	111220
DC+DW+L+T MIN	-137471	-16463	-165190	139236	13746	-165190	-45111	965	-37504	-45110	1001	-37504	931	75	57640
DC+DW+EQ	-131558	-15675	-124794	117238	10627	-124794	-33376	1016	-2839	-33375	1042	-2839	3903	-874	66545
DC+DW-EQ	-135360	-12271	-120518	151960	12863	-120518	-45897	213	-4948	-45896	250	-4948	1564	877	64878

NOTE
DC+DW Dead Load At the end of Creep
T: Thermal Effect
L: Live Load with Impact
{ (+) : Max , (-) : Min }
EQ: Seismic Force

Table Reaction Force after Construction

	P12		P13		P14		Northern Pylon	
	RX(kN)	RY(kN)	RX(kN)	RY(kN)	RX(kN)	RY(kN)	RX(kN)	RY(kN)
*** RX Maximum ***								
DC+DW	-5	5834	-6	18486	-7	25703	2753	409776
DC+DW+L(+)	143	6630	143	20747	141	28314	3027	409555
DC+DW+L(-)	-187	5433	-189	17197	-194	22937	2771	434561
DC+DW+T MAX	402	5756	350	18320	297	26170	3947	409553
DC+DW+T MIN	-413	5912	-363	18652	-313	25237	1560	409999
DC+DW+L+T MAX	551	6552	500	20581	447	28780	4221	409332
DC+DW+L+T MIN	-595	5511	-546	17363	-500	22470	1578	434784
DC+DW+EQ	6412	4637	6412	15912	6410	32569	39844	405805
DC+DW-EQ	-6423	7031	-6424	21059	-6425	18838	-34336	413748
*** RY Maximum ***								
DC+DW	-5	5834	-6	18486	-7	25703	2753	409776
DC+DW+L(+)	0	9269	-25	25023	109	32507	4366	424036
DC+DW+L(-)	-45	4336	-22	14388	-173	20337	1456	420388
DC+DW+T MAX	-413	5912	-363	18652	297	26170	3947	409553
DC+DW+T MIN	402	5756	350	18320	-313	25237	1560	409999
DC+DW+L+T MAX	-407	9346	-382	25189	414	32974	5559	423813
DC+DW+L+T MIN	362	4259	334	14222	-479	19870	263	420611
DC+DW+EQ	6412	4637	6412	15912	6410	32569	39844	405805
DC+DW-EQ	-6423	7031	-6424	21059	-6425	18838	-34336	413748

	Southern Pylon		P15		P16		P17	
	RX(kN)	RY(kN)	RX(kN)	RY(kN)	RX(kN)	RY(kN)	RX(kN)	RY(kN)
*** RX Maximum ***								
DC+DW	-2799	409759	23	25714	21	18490	20	5835
DC+DW+L(+)	-3068	409539	208	22947	203	17202	201	5378
DC+DW+L(-)	-2815	434545	-128	28321	-130	20750	-130	6687
DC+DW+T MAX	-3979	409542	333	25253	382	18657	432	5913
DC+DW+T MIN	-1618	409975	-287	26175	-340	18324	-391	5757
DC+DW+L+T MAX	-4249	409322	519	22486	565	17368	613	5456
DC+DW+L+T MIN	-1634	434762	-438	28782	-492	20584	-542	6609
DC+DW+EQ	31920	412998	6451	19755	6450	20949	6449	6972
DC+DW-EQ	-37518	406519	-6405	31673	-6408	16032	-6407	4698
*** RY Maximum ***								
DC+DW	-2799	409759	23	25714	21	18490	20	5835
DC+DW+L(+)	-1516	420388	-95	32521	42	25028	17	9270
DC+DW+L(-)	-4391	424005	187	20342	34	14392	56	4337
DC+DW+T MAX	-1618	409975	-287	26175	382	18657	432	5913
DC+DW+T MIN	-3979	409542	333	25253	-340	18324	-391	5757
DC+DW+L+T MAX	-336	420604	-405	32982	403	25194	429	9347
DC+DW+L+T MIN	-5571	423788	498	19881	-326	14225	-355	4259
DC+DW+EQ	31920	412998	6451	19755	6450	20949	6449	6972
DC+DW-EQ	-37518	406519	-6405	31673	-6408	16032	-6407	4698

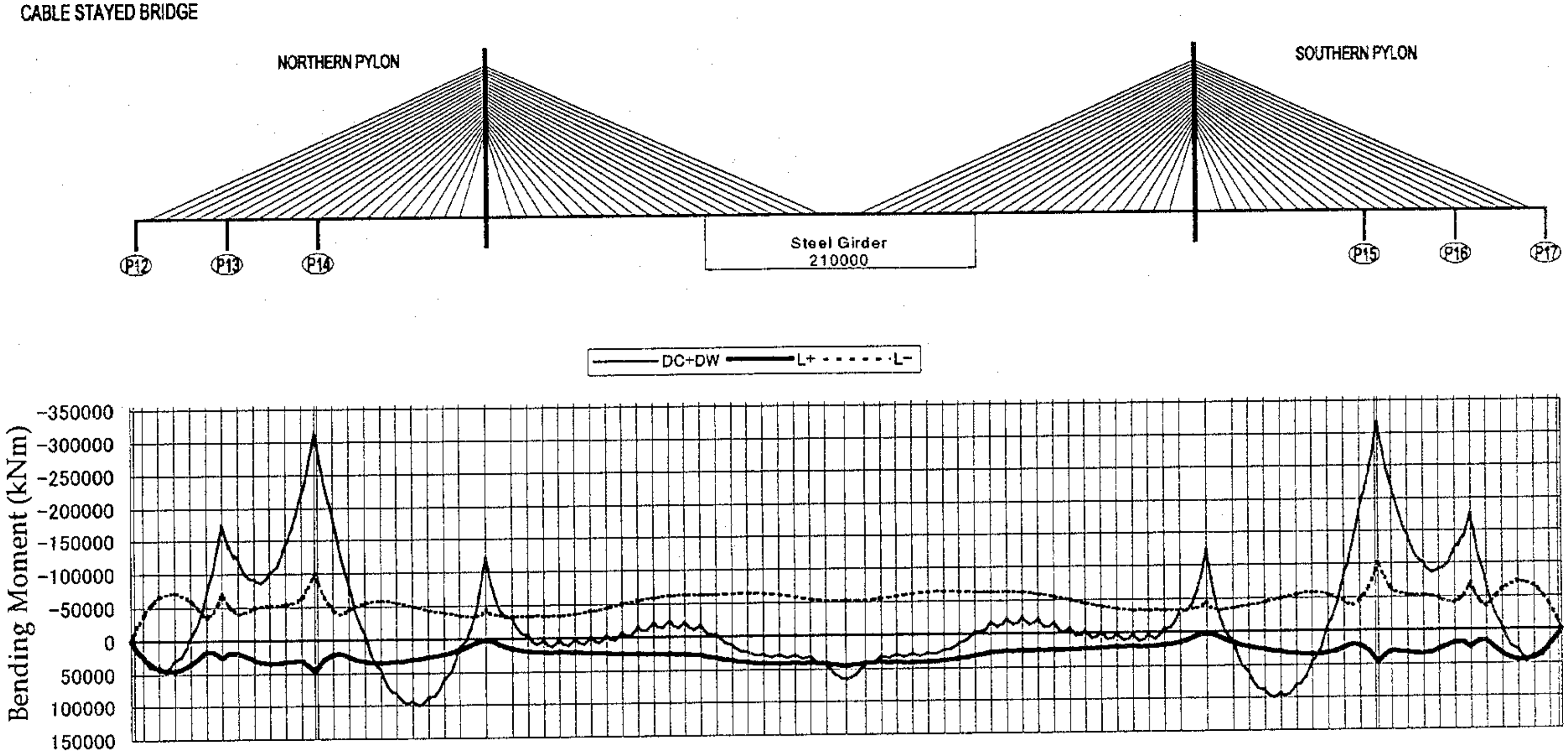


Fig Bending Moment Diagram

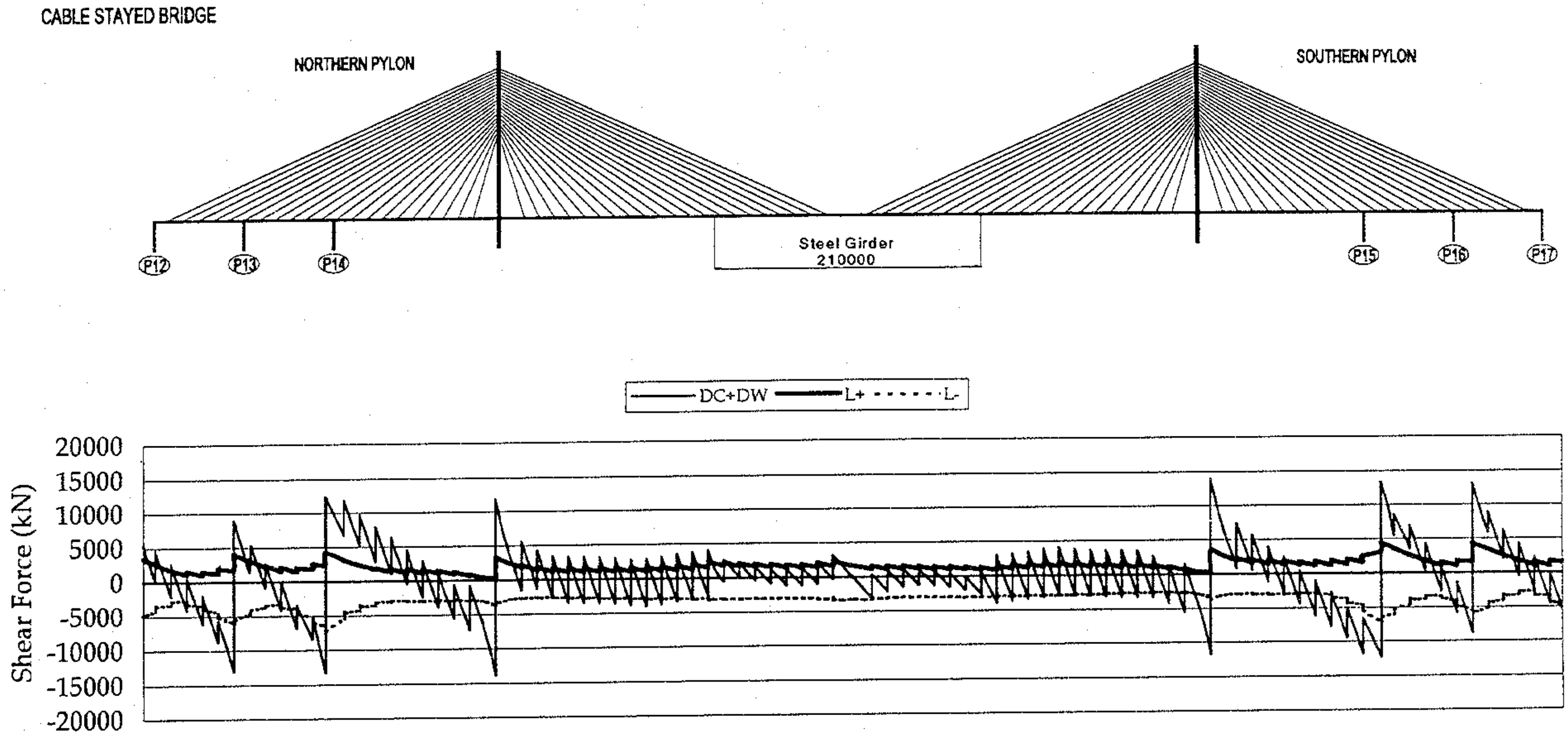


Fig Shear Force Diagram

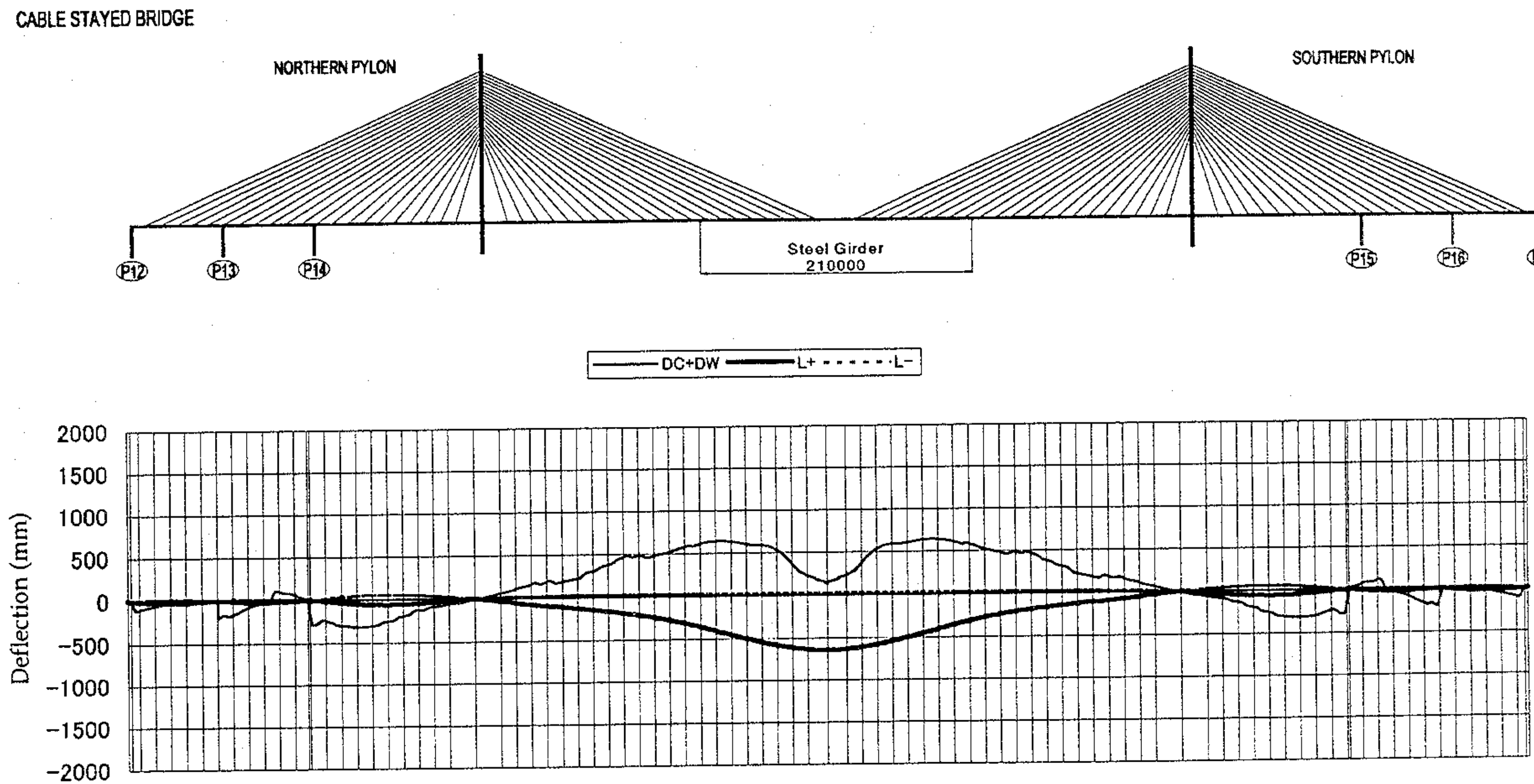


Fig Deflection Diagram

3.5.2 Result of Space Frame Analysis (Pylon)

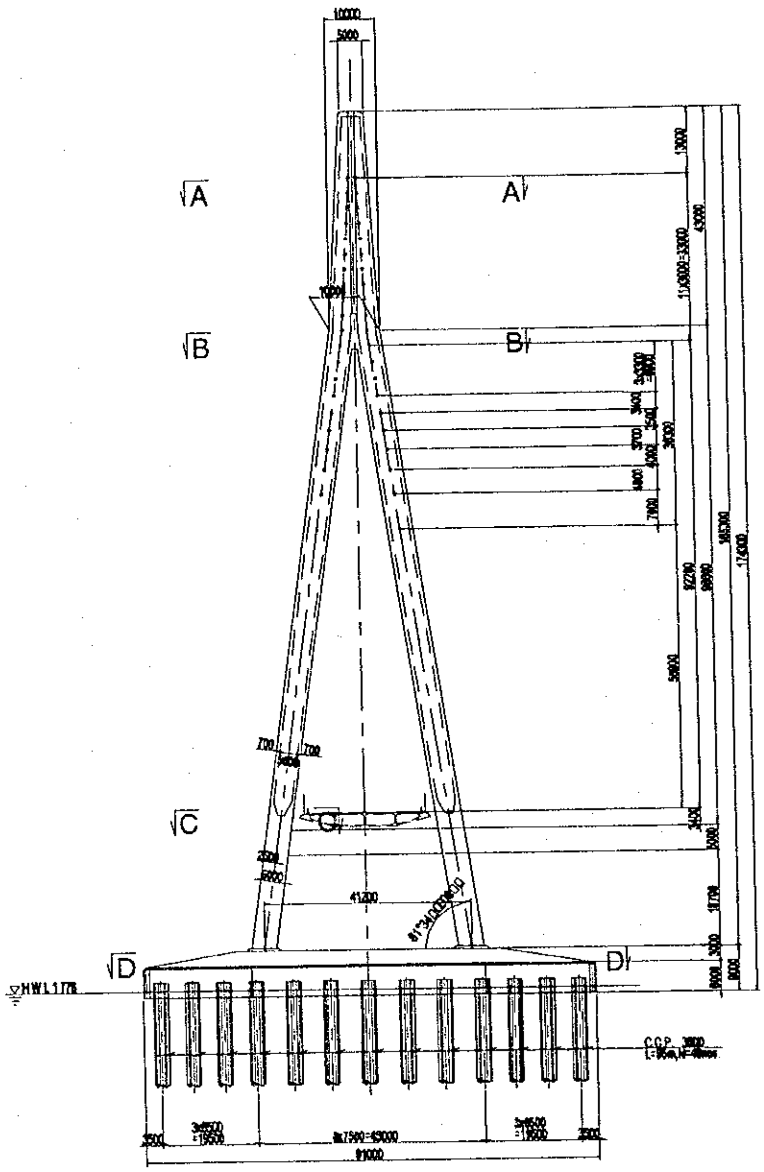


Table SECTIONAL FORCES AT PYLON

LONGITUDINAL DIRECTION

		A-A Axial Force (kN)	A-A Shear Force (kN)	A-A Bending Moment (kNm)	B-B Axial Force (kN)	B-B Shear Force (kN)	B-B Bending Moment (kNm)	C-C Axial Force (kN)	C-C Shear Force (kN)	C-C Bending Moment (kNm)	D-D Axial Force (kN)	D-D Shear Force (kN)	D-D Bending Moment (kNm)
DC		-12674	-3133	0	-102292	-11317	-549286	-151144	2157	-145655	-187483	2167	-86956
DW		-1429	665	0	-16467	1556	46604	-14799	131	42055	-16742	-32	41446
LL	Mmax	0	0	0	-8675	2753	81930	-10308	572	43832	-9638	587	57428
	Mmin	0	0	0	-5234	-1779	-44303	-1227	-536	-12980	-3097	-594	-27063
	Smax	-971	1100	0	-10948	3466	65337	-6682	882	33303	-6800	719	50854
	Smin	-263	-485	0	-2889	-2546	-34058	-4606	-754	-3567	-5842	-713	-20944
	Nmax	40	49	0	1107	1672	10918	127	72	3544	107	135	7258
	Nmin	-1233	692	0	-14145	489	33329	-11359	48	29950	-12640	-158	25781
WS	→	0	604	3391	-6101	-2234	4824	-5533	1747	-6305	-4775	16368	392351
	←	0	-604	-3391	6101	2234	-4824	5533	-1747	6305	4775	-16368	-392351
WL	L→R	0	0	0	0	0	0	-15	7	435	-443	-307	-2766
	R→L	0	0	0	0	0	0	15	-7	-435	443	307	2766
TU	Up	42	76	0	117	13	5222	-28	-224	-16572	-121	-603	-32346
	Down	-42	-76	0	-117	-13	-5222	28	224	16572	121	603	32346
CR		1	2	0	-3	-1	53	-2	1	171	1	1	193
SH		0	0	0	0	0	0	0	0	8	0	0	12
TG		-18	19	0	-208	55	3219	-113	-62	-3638	-56	-89	-6012
EQ	→	-104	-1662	3035	-63	-2057	-127524	2236	7865	401343	2271	18605	851952
	←	104	1662	-3035	63	2057	127524	-2236	-7865	-401343	-2271	-18605	-851952

TRANSVERSAL DIRECTION

		A-A Axial Force (kN)	A-A Shear Force (kN)	A-A Bending Moment (kNm)	B-B Axial Force (kN)	B-B Shear Force (kN)	B-B Bending Moment (kNm)	C-C Axial Force (kN)	C-C Shear Force (kN)	C-C Bending Moment (kNm)	D-D Axial Force (kN)	D-D Shear Force (kN)	D-D Bending Moment (kNm)
DC+DW		-14102	0	0	-118762	0	0	-165945	-2710	-31498	-204224	-14738	-193035
LL	Mmax	-389	5	35	-8306	130	3937	-4974	20	319	-5510	133	544
	Mmin	389	-5	-35	-8306	-130	-3837	-7318	-32	-637	-8034	-242	-2198
	Smax	-389	5	35	-8306	130	3937	-4974	20	319	-5510	133	544
	Smin	389	-5	-35	-8306	-130	-3837	-7318	-32	-637	-8034	-242	-2198
	Nmax	11	0	0	974	0	0	0	0	0	0	0	0
	Nmin	-651	0	0	-13850	0	0	-10652	-11	-301	-11262	-91	-1376
WS	L→R	1	1342	3662	-10	9613	174764	-49566	3145	91060	-69311	11359	117462
	R→L	1	-1342	-3662	-10	-9613	-174764	49753	-4692	-109440	69281	-11173	-116721
WL	L→R	0	0	1	0	5	92	-15	1	10	-443	322	2934
	R→L	0	0	-1	0	-5	-92	15	-1	-10	443	-322	-2934
EQ	L→R	0	573	3126	-11	2906	55466	-19883	3173	66931	-39495	13390	116879
	R→L	0	-573	-3126	-11	-2906	-55466	19849	-3180	-66778	39495	-13411	-116944

Bending Moment (kNm)
(Load Case 001 : Dead Load)

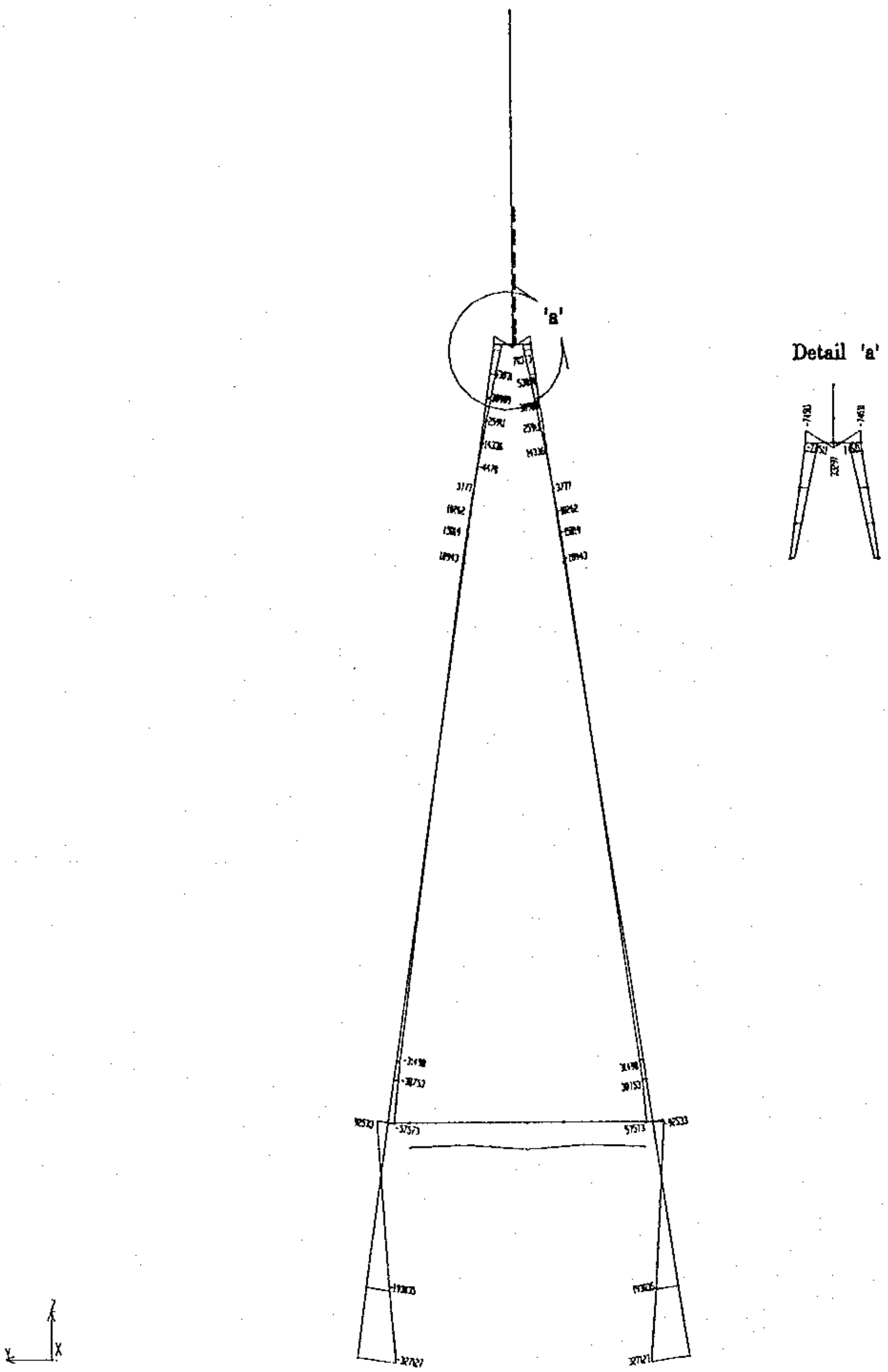


Fig Bending Moment Diagram(Dead Load)

Shear Force (kN)
(Load Case 001 : Dead Load)

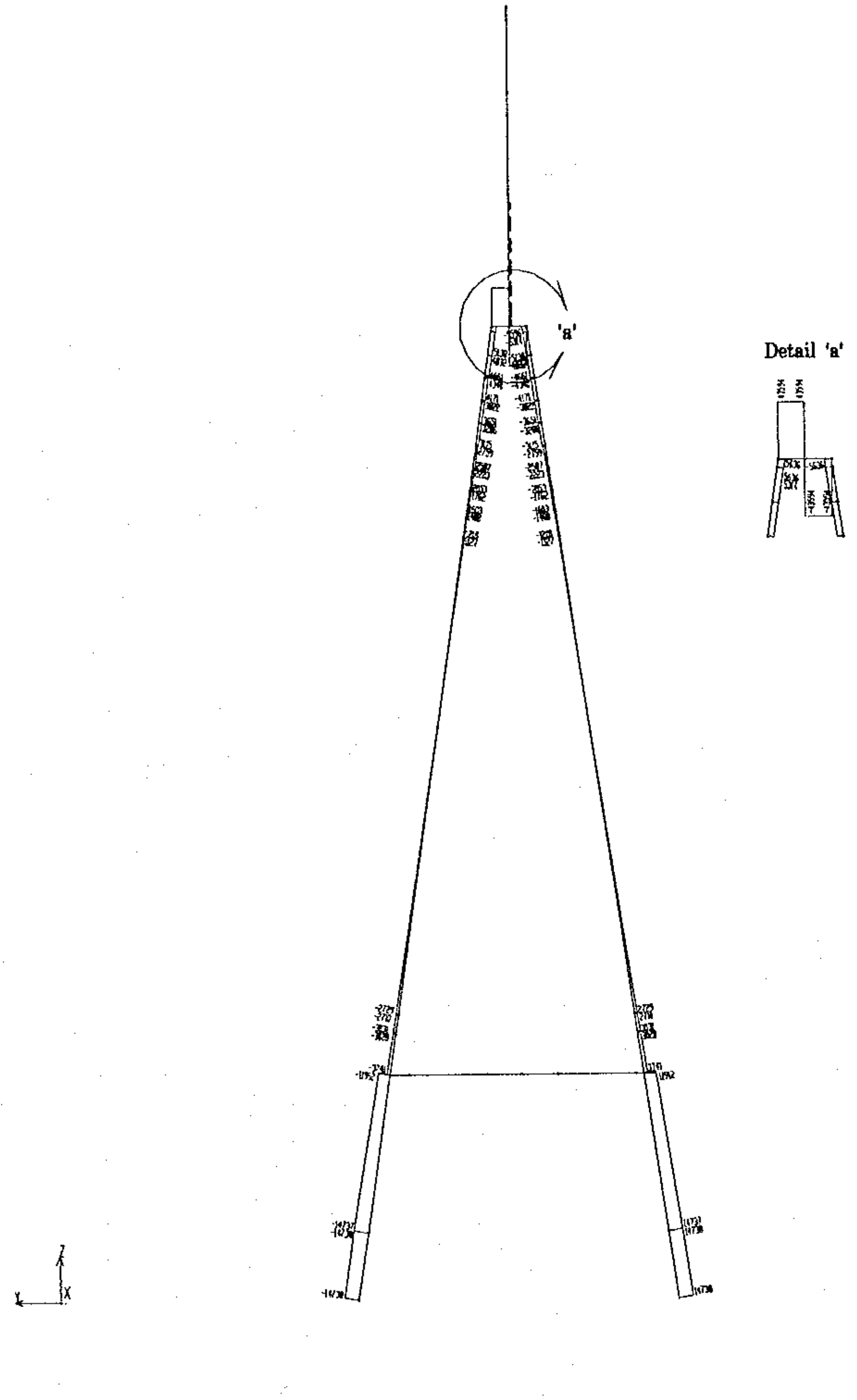


Fig Shear Force Diagram (Dead Load)

Bendng Moment (kNm)
(Load Case 211 : Wind Load on Structureal Component)

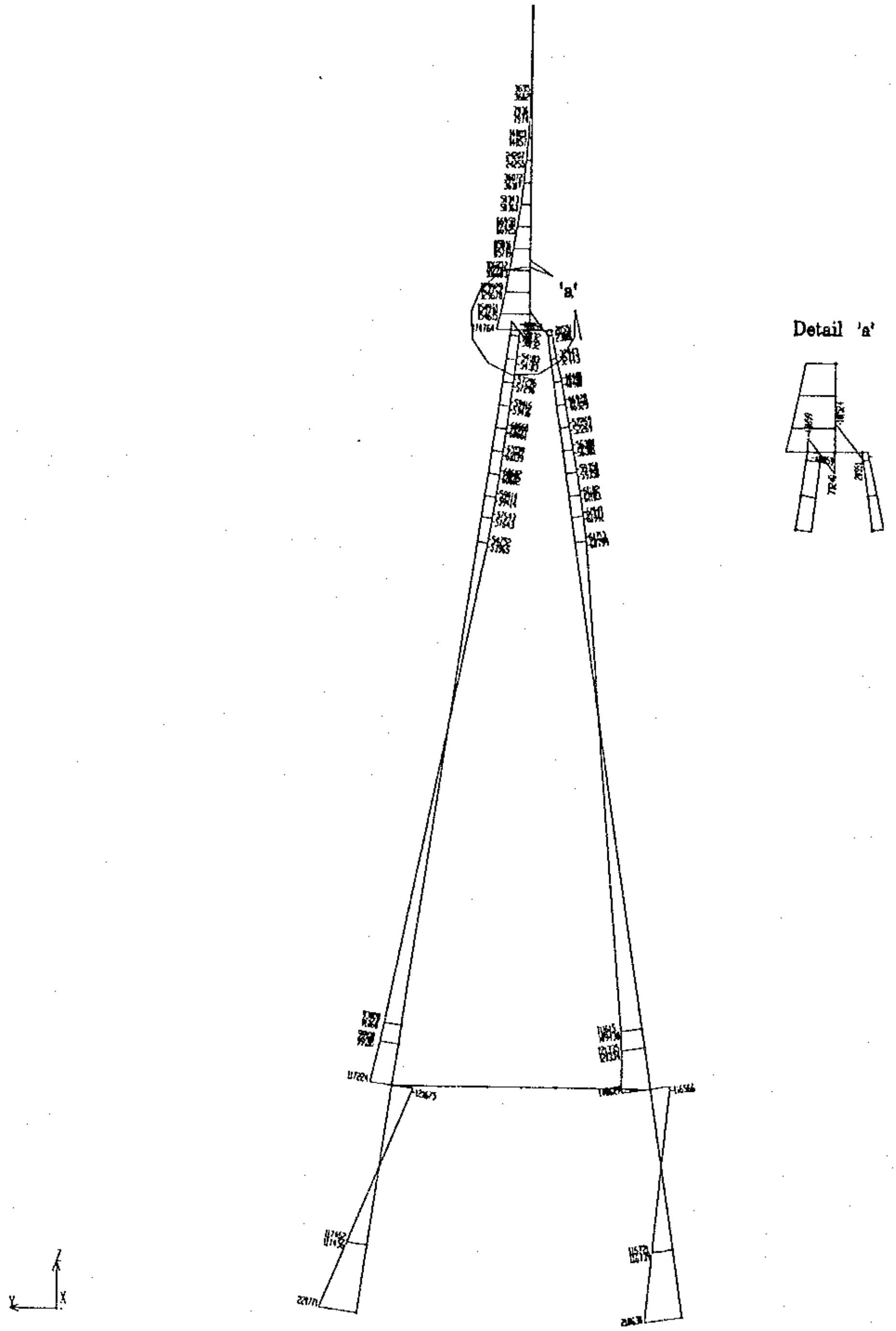


Fig Bending Moment Diagram (Wind Load)

Shear Force (kN)
(Load Case 211 : Wind Load on Structureal Component)

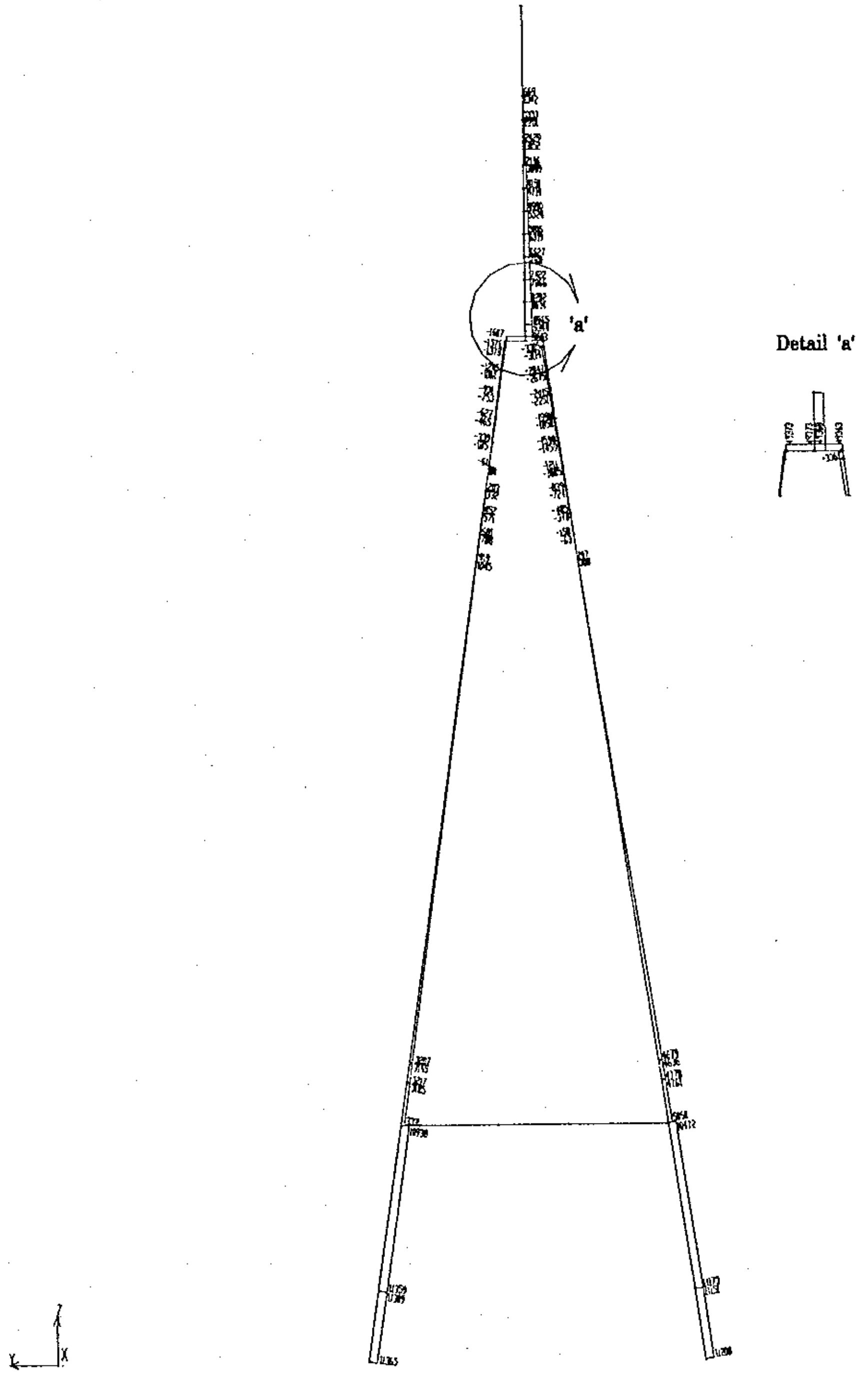


Fig Shear Force Diagram (Wind Load)

Bending Moment (kNm)
(Load Case 221 : Wind on Live Load)

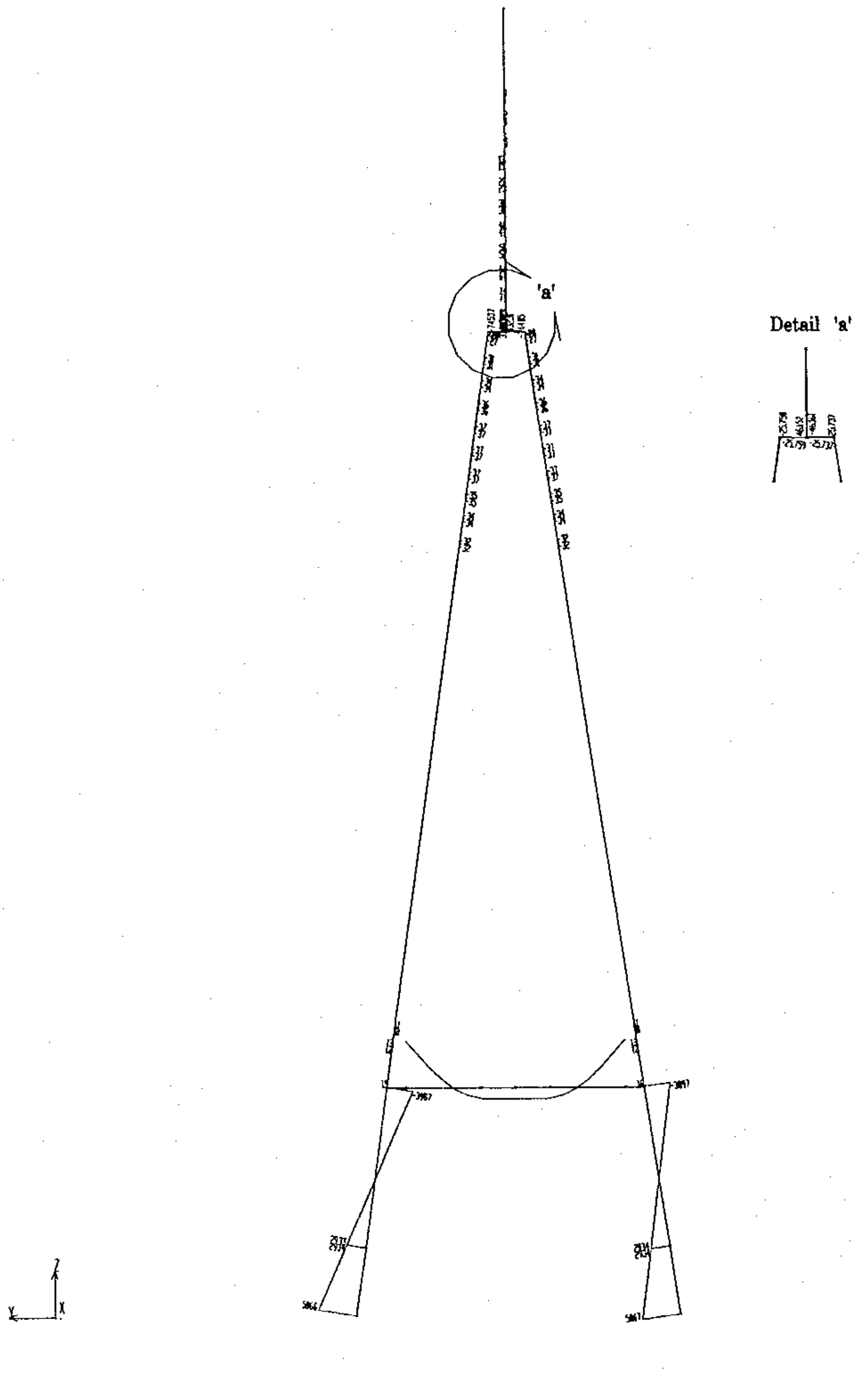


Fig Bending Moment Diagram (Wind on Live Load)

Shear Force (kN)
(Load Case 221 : Wind on Live Load)

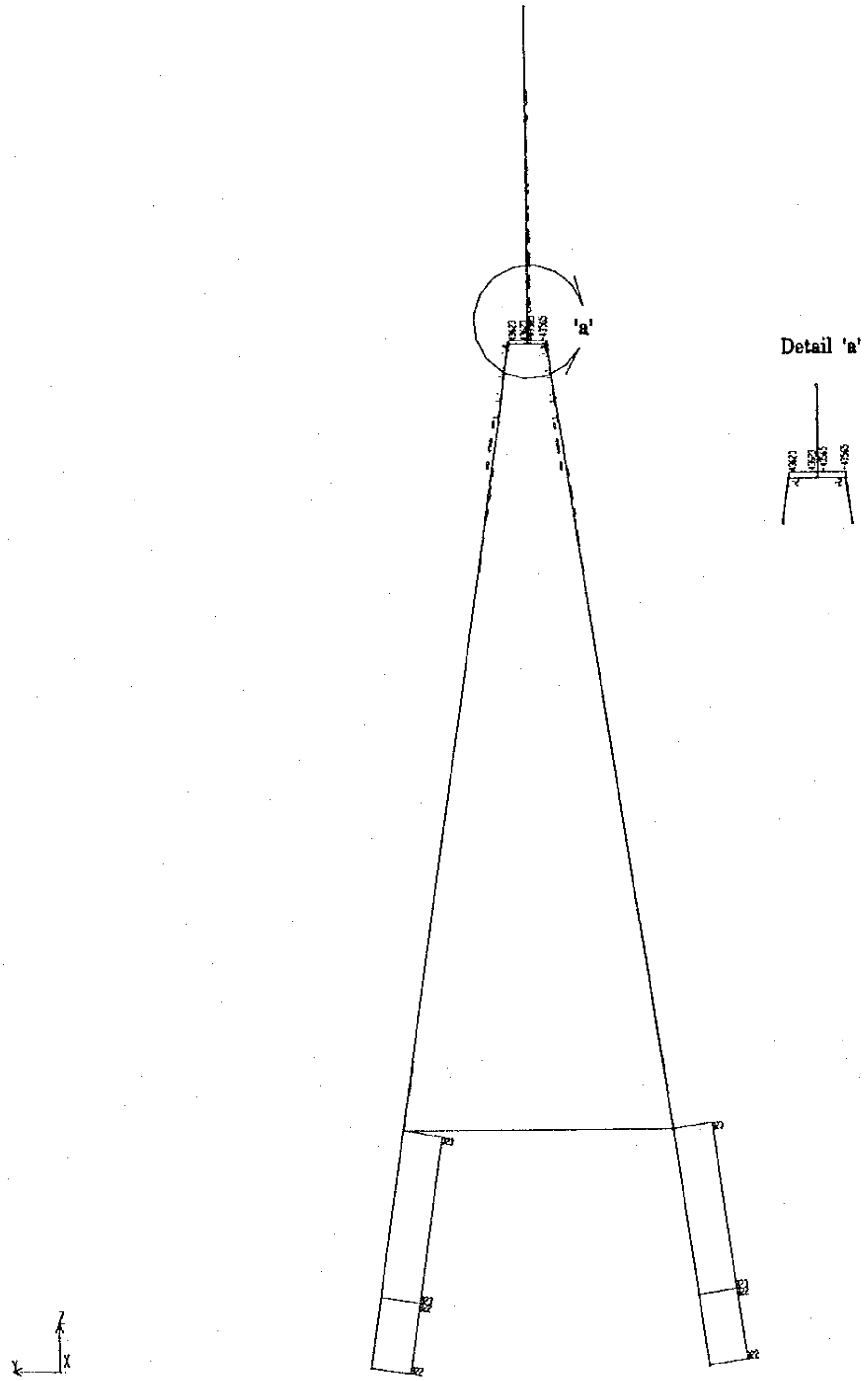


Fig Shear Force Diagram (Wind on Live Load)

Bending Moment (kNm)
(Load Case 301 : Earthquake Load)

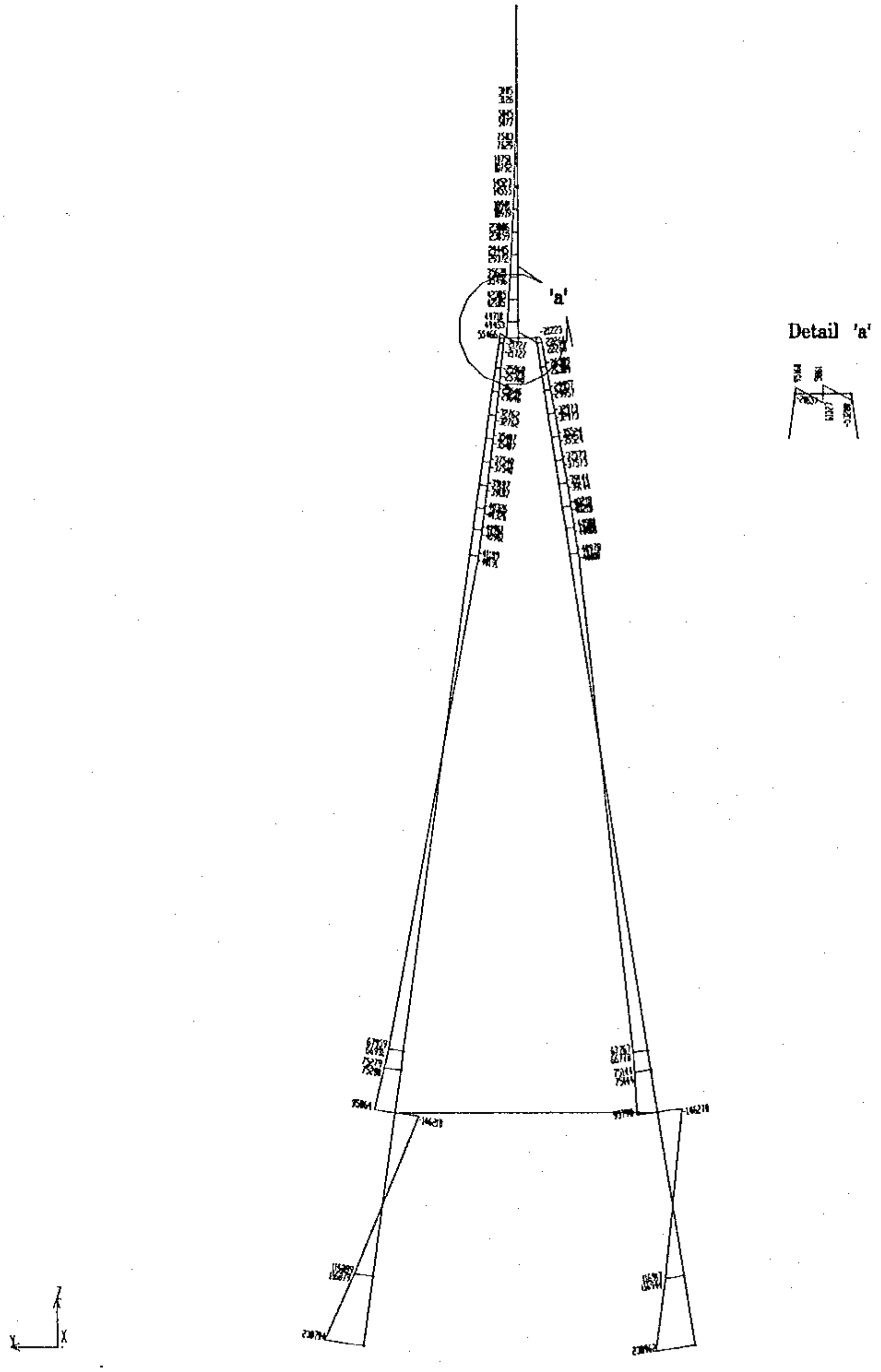


Fig Bending Moment Diagram (Earthquake)

Shear Force (kN)
(Load Case 301 : Earthquake Load)

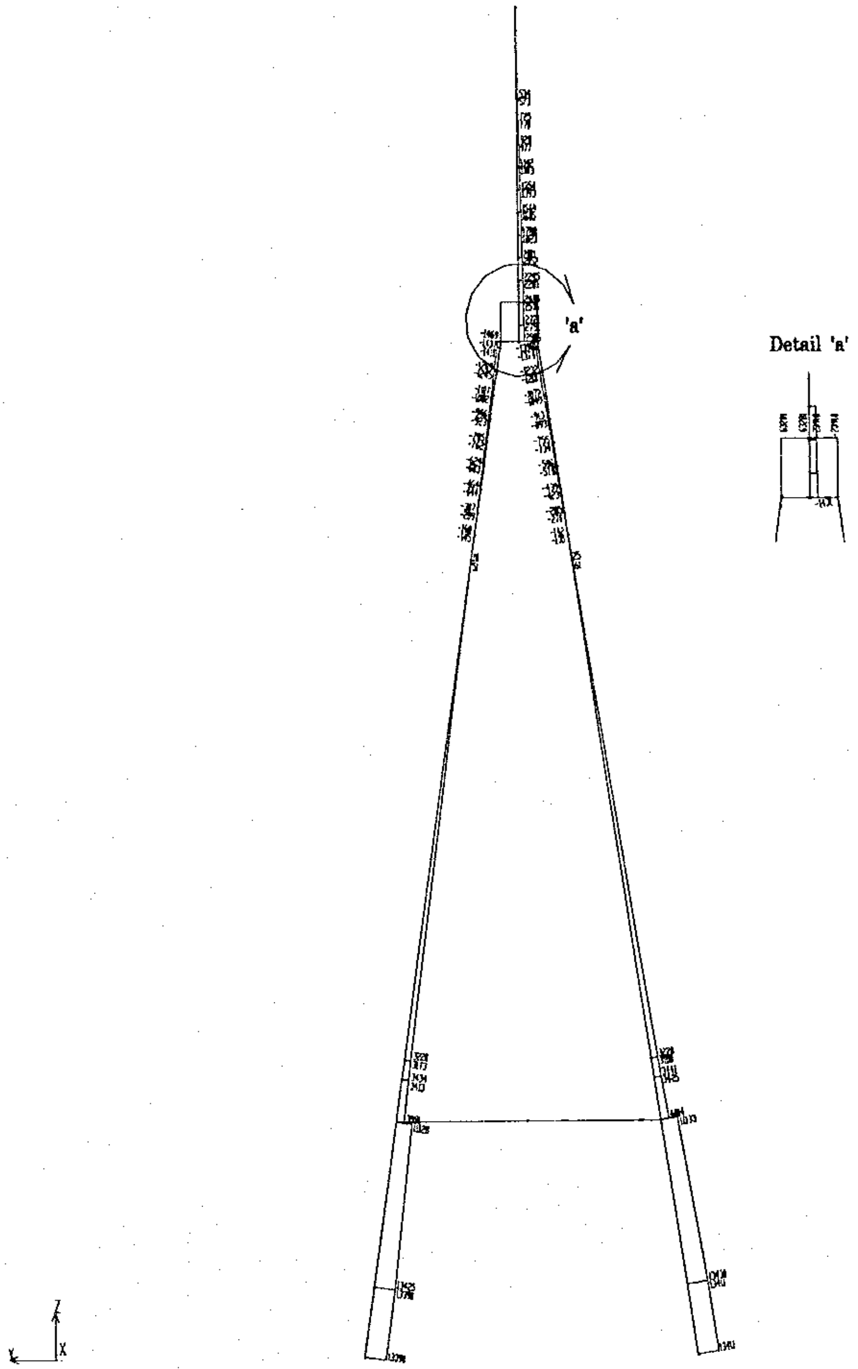


Fig Shear Force Diagram (Earthquake)

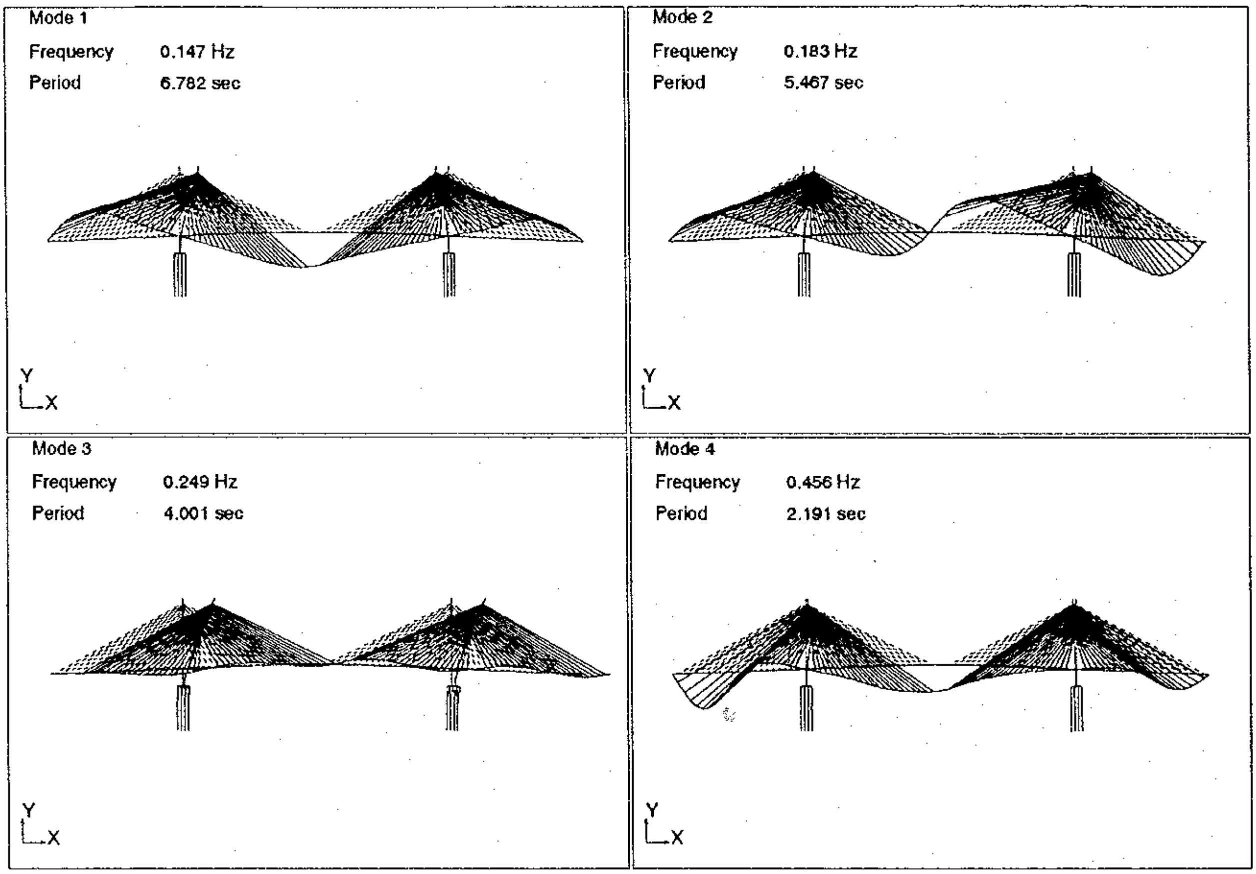
3.6 Analysis of Natural Period

Model for analysis of natural period apply same model as calculation of internal forces. Result of natural period is shown in table.

Table 3.6-1 Result of Natural Period Analysis

MODE	CIRC. FRQ (RAD/SEC)	FREQUENCY (1/SEC)	PERIOD (SEC)		X	Y	RZ
1	0.92644	0.14745	6.782111	E.M	1.41E+02	9.31E+02	
				EMR	0.001	0.004	
2	1.14934	0.18292	5.466763	E.M	1.85E+02	4.54E+01	
				EMR	0.001	0	
3	1.51369	0.24091	4.150910	E.M	8.06E+04	3.33E+00	
				EMR	0.317	0	
4	2.86727	0.45634	2.191346	E.M	2.93E+01	1.73E+04	
				EMR	0	0.068	

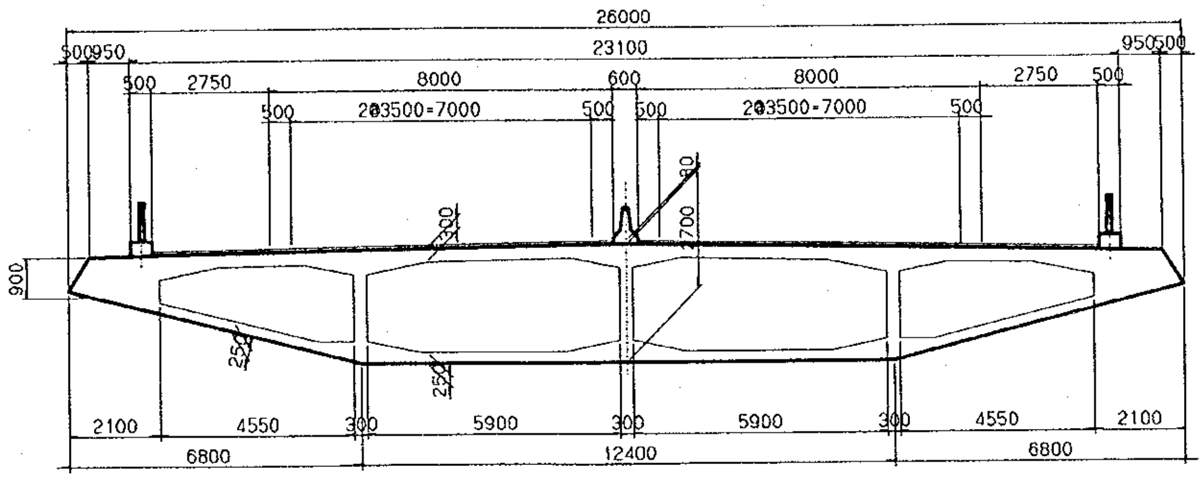
Note;
EM : Effective Mass
EMR : Effective Mass Ratio



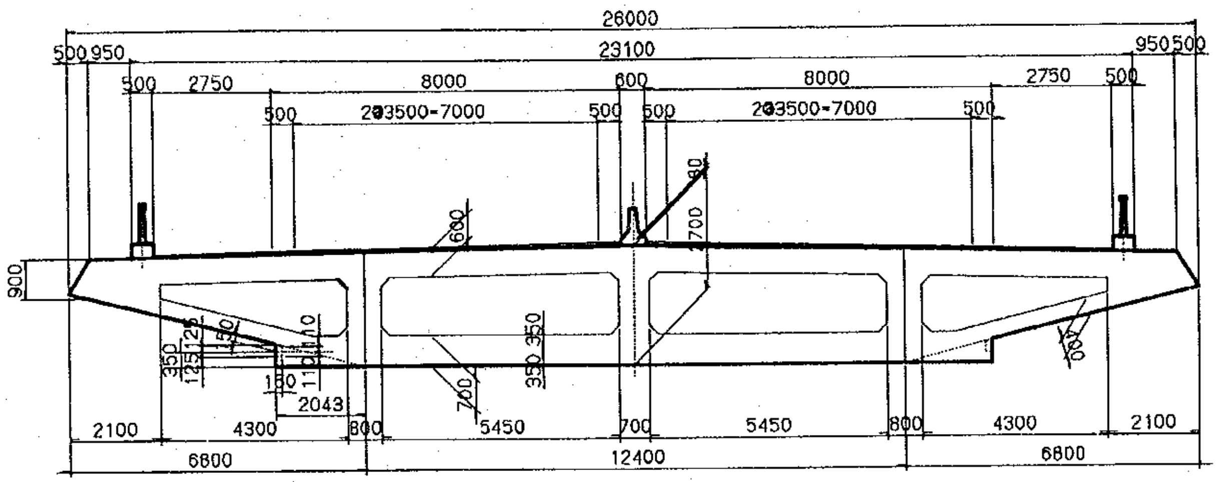
3.7 Design of PC-Girder

3.7.1 Detail of PC-Girder

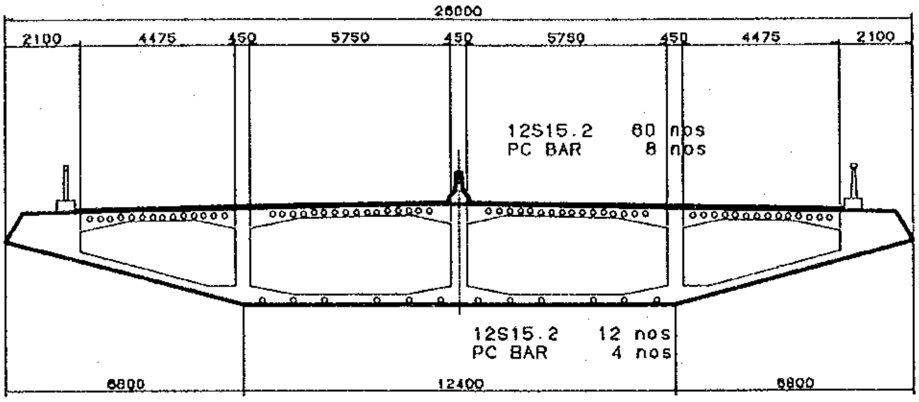
Typical Cross Section at Middle of Span



At Northern and Southern Pylon



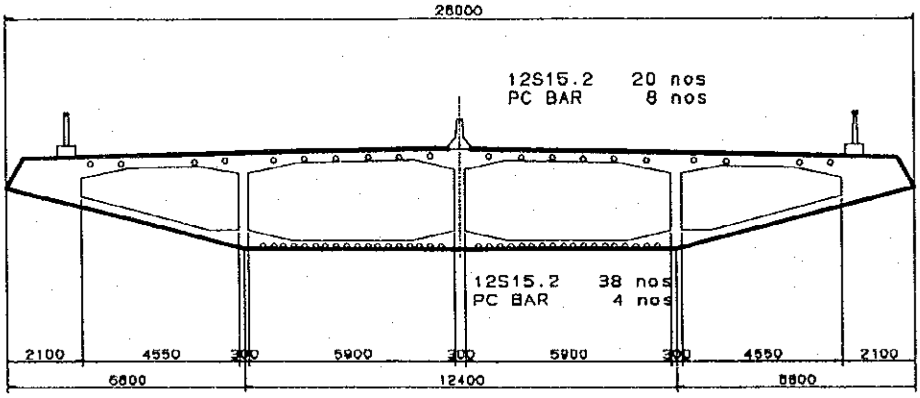
PC Steel Arrangement at Supplementary Pier



∘ PC STEEL 12S15.2

PC BAR φ32

PC Steel Arrangement at Middle of Span

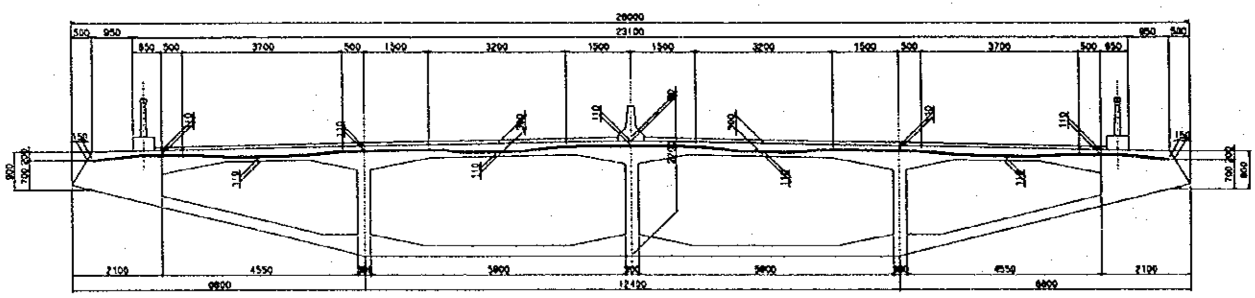


∘ PC STEEL 12S15.2

PC BAR φ32

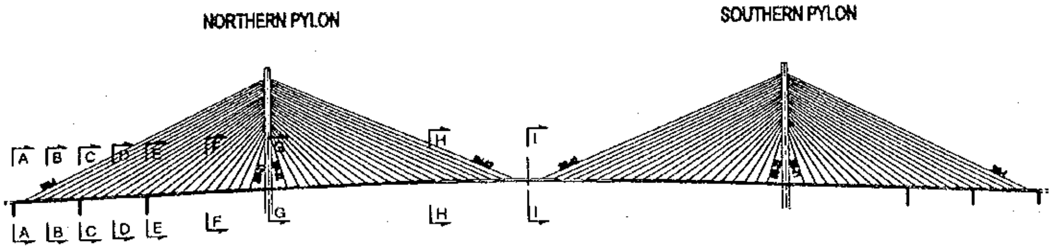
Transverse PC Steel of Deck Slab

4S15.2 ctc..500



3.7.2 Calculation Result

Checking Section



		Section A			Section B					
					Left			Right		
		N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)
DC		-180	5471	0	-18707	-3064	48686	-27882	1049	48686
DW		-50	162	0	-2929	-384	-1616	-4411	366	-1616
EL		13	-347	0	752	-707	-18399	1017	-842	-18399
LL	Mmax	0	0	0	31	-334	45138	-6	-301	45138
	Mmin	0	0	0	-2087	-360	-26501	-3098	149	-26501
	Smax	-108	3432	0	31	1058	30921	-3224	1569	13922
	Smin	19	-1498	0	-2145	-1737	6726	-8	-1663	23726
	Nmax	154	-542	0	259	-71	-1420	368	-137	-1303
	Nmin	-233	2628	0	-2624	-257	2786	-3927	432	2663
BR		-150	-6	270	1	-3	-81	-149	-9	189
		150	6	-270	-1	3	81	149	9	-189
WS		15	-461	0	-1665	6	-7371	-2582	298	-7371
WL		0	0	0	0	0	0	0	0	0
SH		0	0	0	1	0	1	1	0	1
CR		154	-542	-1455	367	-137	-1304	367	-137	-1458
TU		-615	92	0	-386	-20	971	-299	-63	971
TG		-59	254	0	-74	261	8565	-73	260	8565
EQ		6394	-943	0	1510	178	-10327	483	663	-10327
		-6396	942	0	-1511	-179	10327	-483	-663	10327
CV	LR	0	-11	0	-21	0	-173	-34	7	-173
	RL	0	11	0	21	0	173	35	-7	173

		Section C						Section D					
		Left			Right			Left			Right		
		N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)
DC		-40432	-11620	-120511	-48254	7971	-120511	-60427	-4380	-65746	-66674	-1013	-65746
DW		-6916	-441	-2089	-8273	484	-2089	-10815	-157	2399	-11836	477	2399
EL		1447	-1068	-53174	1568	481	-53174	1746	378	-37818	1772	361	-37818
LL	Mmax	-5738	1811	26345	-6674	-1622	26345	-1180	-81	34226	-1461	111	34226
	Mmin	-64	-3603	-42835	-287	2520	-42835	-6111	-289	-17562	-6526	-38	-17562
	Smax	-5987	1849	24921	-152	3993	-34463	-4156	1561	17485	-9189	2075	16107
	Smin	301	-4199	-33689	-6711	-1624	26325	-3389	-1750	15009	841	-1741	16388
	Nmax	639	-827	-10440	785	825	-5949	1172	-944	-1498	1386	-672	-9414
	Nmin	-6194	258	6260	-7400	-288	1805	-9745	703	3090	-10731	918	10933
BR		2	-3	-182	-149	2	88	1	3	24	-149	-3	294
		-2	3	182	149	-2	-88	-1	-3	-24	149	3	-294
WS		-4253	845	13169	-4995	-1194	13169	-7720	82	-8514	-9294	900	-8514
WL		0	0	0	0	0	0	0	0	0	0	0	0
SH		2	0	-1	2	0	-1	2	0	0	2	0	0
CR		783	825	-5948	783	825	-5027	1384	-672	-9414	1384	-672	-10117
TU		-198	-117	-2316	-722	98	-2316	-758	119	1401	-806	149	1401
TG		-89	269	18105	-135	-100	18105	-192	-67	15042	-213	-54	15042
EQ		-3317	1178	23762	2775	-975	23762	296	-1185	-13876	649	-1445	-13876
		3317	-1178	-23762	-2774	975	-23762	-295	1184	13876	-649	1445	13876
CV	LR	-59	19	289	-70	-27	289	-122	3	-181	-154	23	-181
	RL	59	-19	-289	70	27	-289	122	-3	181	155	-23	181

		Section E						Section F					
		Left			Right			Left			Right		
		N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)
DC		-75366	-13522	-297802	-76424	13995	-297802	-95479	1652	110048	-100040	5811	110048
DW		-13784	-218	7085	-13819	-605	7085	-17746	-346	-4899	-18593	502	-4899
EL		1734	389	-25704	1791	-1056	-25704	830	-247	-59809	591	-8	-59809
LL	Mmax	-12215	2283	47490	-12171	-3081	47490	1629	-249	34027	1144	286	34027
	Mmin	1548	-2906	-53282	1440	3384	-53282	-15369	-128	-24058	-15696	209	-24058
	Smax	-12337	2286	47435	1063	4109	-44595	1300	1320	21587	-11264	1728	5132
	Smin	1144	-4314	-44126	-12220	-3082	47482	-12740	-1736	3460	-1102	-1129	19915
	Nmax	1908	-1089	-33570	1907	2318	-32759	1919	181	22889	1481	518	20757
	Nmin	-12702	493	29671	-12737	-2468	29195	-15870	-124	-23590	-16183	197	-23601
BR		1	1	55	-149	-6	325	2	0	10	-148	-6	280
		-1	-1	-55	149	6	-325	-2	0	-10	148	6	-280
WS		-13095	3053	56653	-12804	-4163	56653	-18561	-261	-26795	-19143	163	-26795
WL		0	0	0	0	0	0	0	0	0	0	0	0
SH		3	0	-2	3	0	-2	3	0	0	3	0	1
CR		1904	2318	-32757	1904	2317	-28283	1478	518	20757	1478	469	21242
TU		-974	261	8312	-1404	-456	8312	-1833	-110	-4397	-1901	-42	-4397
TG		-244	-33	13580	-278	-16	13580	-303	3	13326	-308	7	13326
EQ		-346	-2558	-79953	5794	4559	-79953	5972	1198	49611	6564	550	49611
		345	2558	79953	-5793	-4559	79953	-5972	-1197	-49610	-6565	-551	-49610
CV	LR	-238	77	1463	-231	-103	1463	-358	-5	-539	-368	4	-539
	RL	238	-77	-1464	231	103	-1464	359	5	539	368	-4	539

		Section G						Section H					
		Left			Right			Left			Right		
		N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)	N(KN)	S(KN)	M(KNM)
DC		-113393	-13185	-65371	-114008	10880	-65371	-31179	-772	101896	-31180	-748	101896
DW		-20037	-1933	-39115	-20590	2053	-39114	-10379	729	-14290	-10378	738	-14290
EL		-25	1139	-18460	1	-1192	-18460	1923	659	-91530	1924	657	-91530
LL	Mmax	-13046	256	3024	-13638	-124	3024	-2301	403	30013	-2289	405	30013
	Mmin	-2711	-2490	-39897	-2567	1850	-39897	-7658	334	-32960	-7658	340	-32960
	Smax	-14417	340	341	-7735	3203	-31464	-5394	2033	5998	-5418	2037	5906
	Smin	-1187	-3359	-31131	-8023	-296	57	-3391	-1039	10169	-3354	-1036	10262
	Nmax	391	-2571	-10057	689	167	-7096	1311	26	-3115	1311	25	-3116
	Nmin	-16515	-390	-22783	-17165	1288	-20822	-10296	636	-15416	-10293	644	-15416
BR		3	-4	-176	-65	-4	171	77	0	-64	-73	-4	206
		-3	4	176	65	4	-171	-77	0	64	73	4	-206
WS		-19182	-646	-35663	8799	-1000	42042	7966	263	10015	7965	310	10015
WL		0	0	0	0	0	0	0	0	0	0	0	0
SH		2	0	-11	2	0	-11	1	0	0	0	0	0
CR		687	167	-7085	687	167	-6597	1310	25	-3116	1311	25	-3042
TU		-1950	0	-3954	-3104	225	-3954	-3275	-24	975	-3275	-21	975
TG		-340	66	16134	-391	-48	16134	-534	-136	5598	-534	-135	5598
EQ		1901	-1702	-2138	17361	-1118	-2138	6260	402	1054	6261	396	1054
		-1901	1702	2138	-17361	1118	2138	-6261	-401	-1055	-6260	-396	-1055
CV	LR	-317	-82	-3462	2227	-86	3610	2317	3	-115	2317	17	-115
	RL	317	82	3467	-2227	85	-3604	-2317	-3	118	-2316	-17	118