Appendix A Materials of Lectures and Seminars

A-9 Detailed Practice for Steel Box Girder Bridge

Practice Design of Steel Box Girder

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*	Calcuration of Diaphragm at the Bearing Support
*	Calcuration of Diaphragm at the Mid of Girder
*	Vertical Stiffener at the Bearing Support
*	Calculation of Concrete Slab Deck

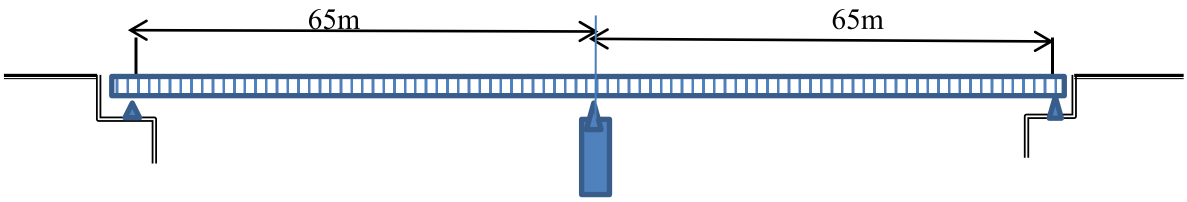
* : not included

1 Condition of Girder Design

2-span continuos Girder
Span length 0.5+65+65+0.5 =131m
Width 0.6+2@3.5+2@3.5+0.6=15.2m
（2-carriageways（4lanes＊3.5m＝14m width） ）

Deck Type RC slab Deck
Alignment Vertical Curve 500m R
Horizontal straight
Superelevation ±2%

Navigation Height



2 Design Items

a Evaluation of Dead Load
i Pavement: Thickness 60mm(Carriageway) (Unit Weight 22.5kn/m^3)
ii Concrete Slab : Assumed weight due to 220mm thickness that depeds on spacing of girder.
(Unit Weught: 24.5Kn/m^3
iii Concrete Curb : Definite weight due to 600m width and 200mm height (Same as Slab)
iv Assumed Steel Weight : Provisionally assumed steel weight?
v Additional Weight GurrdRail : 0.5kn/m)

b Trial Design of Girder Arrangement
i Calculation as Beam Analysis according that calculation of Bending Moment by using MIDAS.
Comparison with several cases so that number of girders is from 2- Girders to 3- Girders
ii Creation of Input Data for Frame Analysis
iii Trial calculation of Bending Moment of inertia and Torsional Moment of Inertia of the main Girder
iv Comparison of Moment differences in case that Stiffeness ratio between main girder and cross gider will be changed.
v Whole section compositions of selected case as the most suitable one

c Making Section Composition of Selected case as the most suitable one
i Calculation of section properties and stress at each position
ii Decision of Segment Length
iii Calculation of Sttifeners in accordance with the Panel Aspect

d Design of Cross Girder
- i Calculation of section properties and stress at each position
- ii Calculation of Sttifeners in accordance with the Panel Aspect
- iii Calculation of Splice Plates

e Detail Calcvulation of Stress Check
- i Picking up of Stress Combination
- ii Bi-AxialStress Check

f Design of Splice Joint at every joint
- i Calculation of Required bolts
- ii Bolt Arrangement
- iii Calculation of Splice Plates

g Design of Weld Joint
- i Required welding condition
- ii Calculation of Stress

h Desing of Diaphramn
- i Diaphramn at Bearing Point
- ii Diaphramn at Cross Girder
- iii Intermediate Diaphramn

i Desing of Concrete Slab
- i Decision of Slab Thickness
- ii Decision of Need of Longitudinal Beam

j Estimation of Steel Quantity
- i Steel weight of each grade and thickness
- ii Painting Area
- iii Concrete Bolume and Quantity of Re-bars

Dead Load

Item		Unit weigl	Width	Thickness:m	Unit weigl	Unit weight	
unit		Kn/m³	m	mm	Kn/m²	Kn/m	
Pavement	Cariagewau	22.5	14	60	1.35	**18.9**	
	Pedestrianwa	22.5	3	20	0.45	1.35	
Slab	Cariagewau	24.5	18.6	220	5.39	**100.25**	
Pede.Slab	Pedestrianwa	24.5	3	100	2.45		
Curb	Left	24.5	0.6	200	4.9	**2.94**	
	Median]	24.5	0.6	200	4.9	**2.94**	
	Right	24.5	0.4	200	4.9	**1.96**	
Guard Rail	Both Sides					**1.00**	
						129.34	
Steel weight (assumed)					6.954	129.34	43.11467
						258.688	

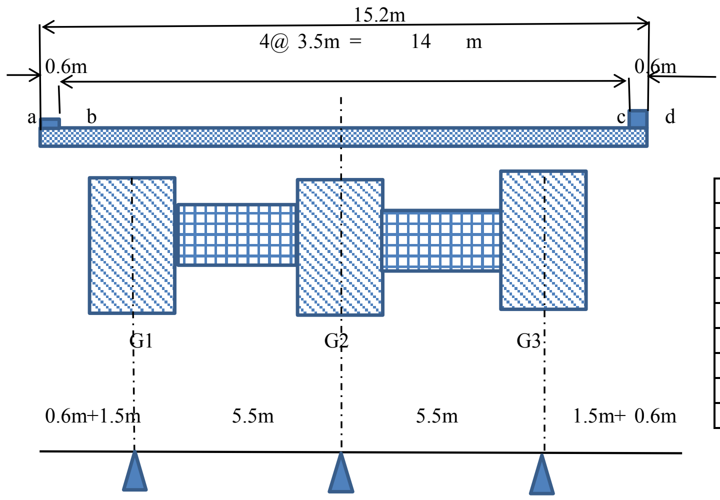
Live Load

Item		Load/1-La	Lane	Deduction	Concentrat	Total	
					Kn	Kn/m	
Vihecle	Uniform	9.3	4	0.65		24.18	
	Concentrat	325	4	0.85	718.25		51.30357
Pedestrain	y	10.8	1			10.8	
Total					718.25	34.98	

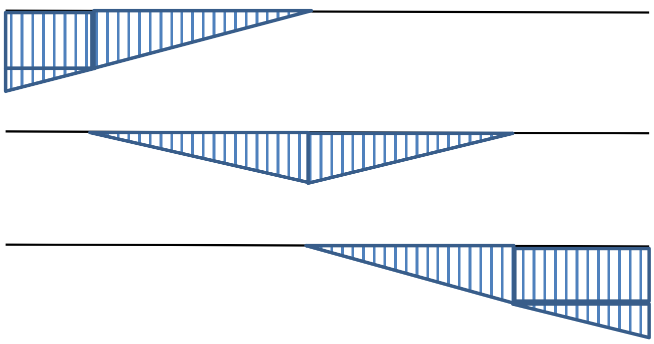
Bending Moment in accordance with Infulence Line M Kn-m

				Mid Pier		Center of Span	
Dead Load	Uniform	258.688	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*
				-80840		40420	
Live Load	Uniform	24.18	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*
				-7556		5670	
Live Load	Concentrat	718.25	Kn	*-0.096*		*0.2064*	
				-3447.6		7412	
Pedestrian	Uniform	10.8	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*
				-3375		2533	
				-95219		**56035**	

	Steel Wei	Guard Rai	Curb	Curb	Pavement		Slab	Pede.Slab	Uni.Live	Truck	
	G1,G2,G	a-b, f-g	a-b,c-d	f-g	b-c,d-e		a-g	e-f	b-c,d-e	b-c,d-e	
Kn/m											
Kn/m^2											



	mm
a	0
b	600
G1	1500
G2	7000
G3	12500
c	14600
d	15200



Position	mm	Height
a	0	1.273
b	600	1.164
G1	1500	1.000
G2	7000	0.000

Position	mm	Height
G1	1500	0.000
G2	7000	1.000
G3	12500	0.000

Position	mm	Height
G2	7000	0.000
G3	12500	1.000
e	14600	1.164
f	15200	1.273

Wheel Load: Kn/m(Translation to uniform load)

	325/3.48=		93.391		
G1,G3	1.00	2-lanes	93.391	0.85	79.382
G2	0.85	3-lanes	79.382	0.85	67.475
	0.65	more ove	60.704	0.85	51.598

0.85 is taken account of the inluence value.
relating wheel spacing

	Steel Wei	Guard Rai	Curb	Curb	Pavement		Slab		Uni.Live	Truck		
	G1,G2,G	a-b, e--f	a-b	e-f	b-e		a-f		b-c	2-Lanes	3-lanes	
Kn/m										79.382	67.475	51.598
Kn/m	19.000	0.5	2.94	2.94								
Kn/m^2					1.35		5.39		2.672	:2-Lanes		
									2.272	:3-lanesn		
									1.737	:more than 3-lanes		
	6840	130	382.2	382.2	2457		9,810		4,650			
Total Load		Σdead Load		20,001					4,650			

!st step:
4-Lanes Loading is calculated

2nd Step
2-Lanes loading is applied
3-Lanes Loadin is applied

G1	Steel Wei	Guard Rai	Curb		Pavement		Slab		Uni.Live	Truck		
	G1	a-b	a-b		b-G2		a-G2		b-G2	b-G2		
Kn/m										51.598		
Kn/m	19.000	0.5	2.94									

Kn/m^2					1.35		5.39		1.7371			
	1.000	1.218	1.218									
					3.724		4.455		3.724	3.724		
	19.000	0.609	3.581									23.191
					5.027		24.010					29.037
												52.227
									6.468			6.468
										192.134		58.696

G2	Steel Weight			Curb	Pavement		Slab		Uni.Live	Truck		
	G2				G1-G3		G1-G3		G1-G3	G1-c		
Kn/m										51.598		
Kn/m	19.000											
Kn/m^2					1.35		5.39		1.7371			
	1.000											
					5.500		5.500		5.500	5.500		
	19.000	0.000	0.000									19.000
					7.425		29.645					37.070
												56.070
									9.554			9.554
										283.791		65.624

G1	Bending Moment in accordance with Infulence Li					Kn-m			Reacrion			
					Mid Pier		Center of Span		End		Mid Pier	
	Dead Loa	Uniform	52.227	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*	0.4376	-0.0625	0.625	0.625
			5,223	kn	-16321		8161		980		3,264	
	Live Load	Uniform	6.468	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*	0.4376	-0.0625	0.625	0.625
			647	kn	-2021		1517		142		404	
	Impact	0.33	213		-667		501		47		133	
	Live Load	Concentra	192.134	Kn	*-0.096*		*0.2064*		1.000		1.000	
					-922.24		1983		192		192	
	Impact	0.33			-304		654		63		63	
					-3915		4654					
					-20236		**12815**		1,423		4,057	

G2	Bending Moment in accordance with Infulence Li					Kn-m			Reacrion			
					Mid Pier		Center of Span		End		Mid Pier	
	Dead Loa	Uniform	56.070	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*	0.4376	-0.0625	0.625	0.625
			5607	kn	-17522		8761		1,052		3,504	
	Live Load	Uniform	9.554	Kn/m	*-0.0625*	*-0.0625*	*0.0938*	*-0.0313*	0.4376	-0.0625	0.625	0.625
			955.39	kn	-2986		2240		209		597	
	Impact	0.33	315.28		-985		739		69		197	
	Live Load	Concentra	283.791	Kn	*-0.096*		*0.2064*		1.000		1.000	
					-1362.2		2929		284		284	
	Impact	0.33			-450		966		94		94	
					-5783		6875					
					-23304		**15636**		1,707		4,676	

表-9.2.4 Minimum Thickness of Cocrte Slab (mm)

床版の区分	Span Direction of Slab		
	Span Direction of Slab : Right Angle		Span Direction of Slab : Palallel Angle
Simple Span Type	$40L+110$		$65L+130$
Continuous Span Type	$30L+110$		$50L+130$
Cantilever Span Type	$0<L\leqq 0.25$	$280L+160$	$240L+130$
	$L>0.25$	$80L+210$	

Effwctive Height of Haunch

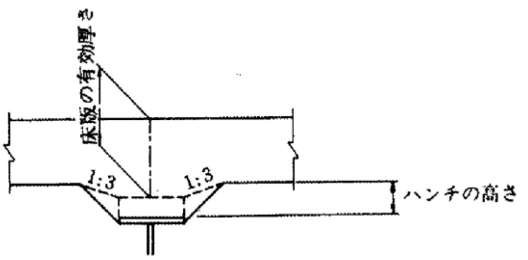
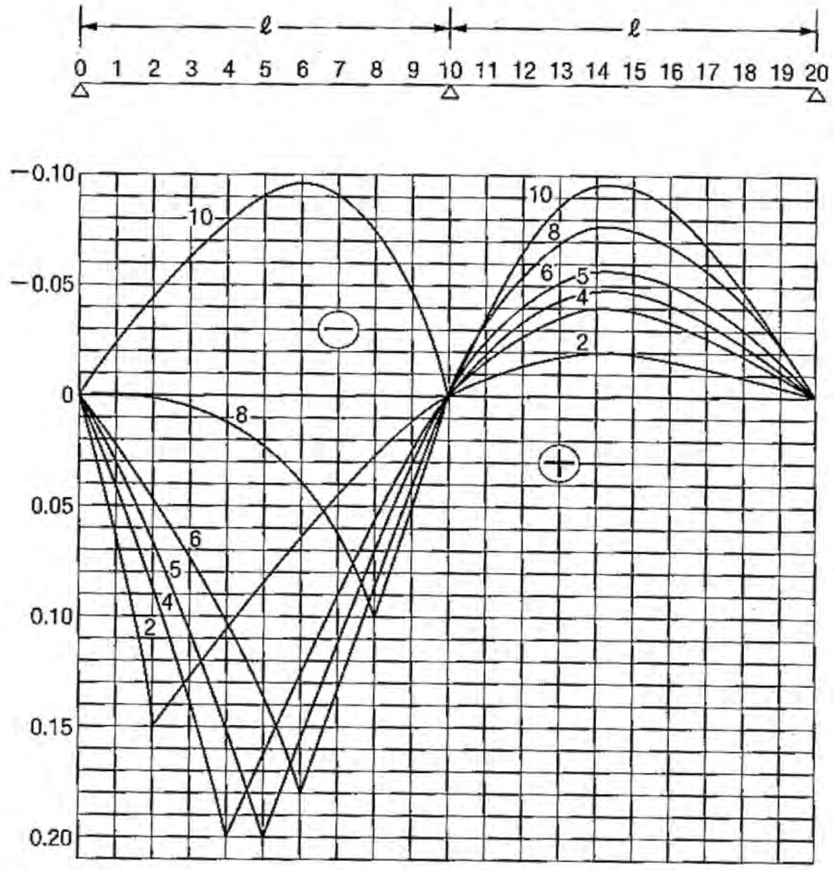


図-9.2.5 ハンチ部の床版の有効厚さ

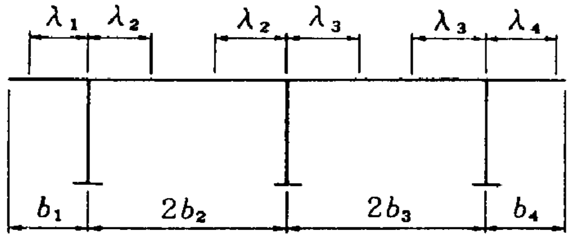
〈曲げモーメント〉



載荷点	着目点													
	曲げモーメント(kN・m)										せん断力(kN)		支点反力(kN)	
	1	2	3	4	5	6	7	8	9	10	$\ell_1(Q_0)$	$\ell_2(Q_{10})$	R_A	R_B
0	0	0	0	0	0	0	0	0	0	0	1.0000	0	1.0000	0
1	0.0875	0.0751	0.0626	0.0501	0.0376	0.0252	0.0127	0.0002	-0.0123	-0.0248	0.8753	0.0248	0.8753	0.1495
2	0.0752	0.1504	0.1256	0.1008	0.0760	0.0512	0.0264	0.0016	-0.0232	-0.0480	0.7520	0.0480	0.7520	0.2960
3	0.0632	0.1264	0.1895	0.1527	0.1159	0.0791	0.0422	0.0054	-0.0314	-0.0683	0.6318	0.0683	0.6318	0.4365
4	0.0516	0.1032	0.1548	0.2064	0.1580	0.1096	0.0612	0.0128	-0.0356	-0.0840	0.5160	0.0840	0.5160	0.5680
5	0.0406	0.0812	0.1219	0.1625	0.2031	0.1438	0.0844	0.0250	-0.0344	-0.0938	0.4063	0.0938	0.4063	0.6875
6	0.0304	0.0608	0.0912	0.1216	0.1520	0.1824	0.1128	0.0432	-0.0264	-0.0960	0.3040	0.0960	0.3040	0.7920
7	0.0211	0.0422	0.0632	0.0843	0.1054	0.1265	0.1475	0.0686	-0.0103	-0.0893	0.2108	0.0893	0.2108	0.8785
8	0.0128	0.0256	0.0384	0.0512	0.0640	0.0768	0.0896	0.1024	0.0152	-0.0720	0.1280	0.0720	0.1280	0.9440
9	0.0057	0.0115	0.0172	0.0229	0.0286	0.0344	0.0401	0.0458	0.0515	-0.0428	0.0573	0.0428	0.0573	0.9855
10	0	0	0	0	0	0	0	0	0	0	0	1.0000	0	1.0000
11	-0.0043	-0.0086	-0.0128	-0.0171	-0.0214	-0.0257	-0.0299	-0.0342	-0.0385	-0.0428	-0.0428	0.9428	-0.0428	0.9855
12	-0.0072	-0.0144	-0.0216	-0.0288	-0.0360	-0.0432	-0.0504	-0.0576	-0.0648	-0.0720	-0.0720	0.8720	-0.0720	0.9440
13	-0.0089	-0.0179	-0.0268	-0.0357	-0.0446	-0.0536	-0.0625	-0.0714	-0.0803	-0.0893	-0.0893	0.7893	-0.0893	0.8785
14	-0.0096	-0.0192	-0.0288	-0.0384	-0.0480	-0.0576	-0.0672	-0.0768	-0.0864	-0.0960	-0.0960	0.6960	-0.0960	0.7920
15	-0.0094	-0.0188	-0.0281	-0.0375	-0.0469	-0.0563	-0.0656	-0.0750	-0.0844	-0.0938	-0.0938	0.5938	-0.0938	0.6875
16	-0.0084	-0.0168	-0.0252	-0.0336	-0.0420	-0.0504	-0.0588	-0.0672	-0.0756	-0.0840	-0.0840	0.4840	-0.0840	0.5680
17	-0.0068	-0.0137	-0.0205	-0.0273	-0.0341	-0.0410	-0.0478	-0.0546	-0.0614	-0.0683	-0.0683	0.3683	-0.0683	0.4365
18	-0.0048	-0.0096	-0.0144	-0.0192	-0.0240	-0.0288	-0.0336	-0.0384	-0.0432	-0.0480	-0.0480	0.2480	-0.0480	0.2960
19	-0.0025	-0.0050	-0.0074	-0.0099	-0.0124	-0.0149	-0.0173	-0.0198	-0.0223	-0.0248	-0.0248	0.1248	-0.0248	0.1495
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	×ℓ(m)										×1.0			
A_1	0.0388	0.0675	0.0863	0.0950	0.0938	0.0825	0.0613	0.0300	-0.0113	-0.0625	0.4375	0.0625	0.4375	0.6250
A_2	-0.0063	-0.0125	-0.0188	-0.0250	-0.0313	-0.0375	-0.0438	-0.0500	-0.0563	-0.0625	-0.0625	0.5625	-0.0625	0.6250
ΣA	0.0325	0.0550	0.0675	0.0700	0.0625	0.0450	0.0175	-0.0200	0.0675	-0.1250	0.3750	0.6250	0.3750	1.2500
	$\times\ell^2(m^2)$										×ℓ(m)			

Effective Width of Flange

The **Shear lag** phenomena causes that flange has not equivalent stress at whole width of flange, but the hiegher stress zone appears near at the web.
So, the eqivalent stress is considered at the effective width(decreased width) of flange.



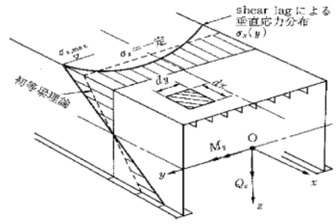
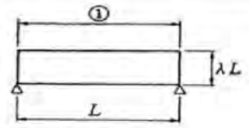
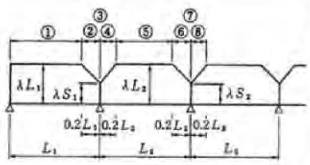
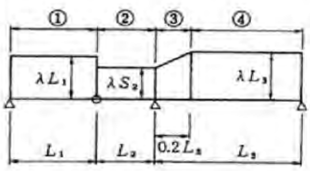


表-11.3.1 フランジの片側有効幅

区間	(箇所)	片側有効幅 記号	適用式	Effectve span	摘要
単純桁	①	λL	(11.3.1)	L	
連続桁	①	λL_1	(11.3.1)	$0.8L_1$	
	⑤	λL_2		$0.6L_2$	
	③	λS_1	(11.3.2)	$0.2(L_1+L_2)$	
	⑦	λS_2		$0.2(L_2+L_3)$	
	②④ ⑥⑧	両端の有効幅を用いて、直線変化させる。			
ゲルバー桁	①	λL_1	(11.3.1)	L_1	
	④	λL_3		$0.8L_3$	
	②	λS_2	(11.3.2)	$2L_2$	
	③	両端の有効幅を用いて、直線変化させる。			

In case of simple span,
it is notneccessary to be considered.

In case of continuous span,
effective width shoul be cosidered at the mid support.

In case of cantilever span,
effective width shoul be cosidered at the mid support.

11.3.1

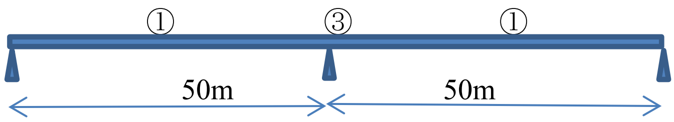
$$\lambda = \begin{cases} b & \left(\frac{b}{l} \leq 0.05\right) \\ \left\{1.1 - 2\left(\frac{b}{l}\right)\right\} b & \left(0.05 < \frac{b}{l} < 0.30\right) \\ 0.15l & \left(0.30 \leq \frac{b}{l}\right) \end{cases}$$

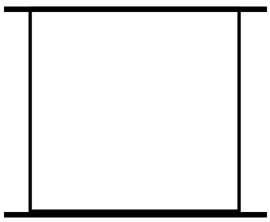
if b＜0.05Le
λ=b (Whole width effective)

11.3.2

$$\lambda = \begin{cases} b & \left(\frac{b}{l} \leq 0.02\right) \\ \left\{1.06 - 3.2\left(\frac{b}{l}\right) + 4.5\left(\frac{b}{l}\right)^2\right\} b & \left(0.02 < \frac{b}{l} < 0.30\right) \\ 0.15l & \left(0.30 \leq \frac{b}{l}\right) \end{cases}$$

if b＜0.02Le
λ=b (Whole width effective)





① Le=0.8L=40m
b=1.8m/2=0.9m ＜0.05Le
=2m
λ=b

③ Le=0.2×100=20m
b=1.8m/2=0.9m ＞0.02Le
=0.4m
b/Le= 0.045
λ=1.06-{(3.2(b/Le)+4.5(b/Le)^2}･b
= 0.832601
93%
2b=1.8･0.93
1.665 m
Wf= 1800×0.93+2@100
1874

Flange width shall be revised to 1874mm at the mid pier,

G1 -31792 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	—Flange	2000	27	540	126	68,229	8,620,734
1	—stiff	140	12	17	118	1,982	234,198
2	—Web	2500	10	500	0	0	2,604,167
3	—stiff	140	12	50	-118	-5,947	702,044
1	—Flange	2000	25	500	-126	-63,125	7,969,531
Σ	Σ			1,607		1,139	20,130,674
				e=	0.7		807
				I=			20,131,481

Iy= 0.20131481 m4

Zu= 0.1602 m^3 σa= 210 n/mm^2= 210,000 Kn/m^2

Zl= -0.1586 m^3 σa= 210 n/mm^2= 210,000 Kn/m^2

w= σu= -198,413

σl= 200,493

		Width/H	Thickne	Area	X cm	AX cm3	AX^2+I0
1	—Web	2000	27	540		0	1,800,000
1	—stiff	140	12	17	0	0	0
1	—Flange	2500	10	250	90	22,500	2,025,000
1	—Flange	2500	10	250	-90	-22,500	2,025,000
3	—stiff	140	12	34	45		68,040
1	—Web	2000	25	500	0	0	1,666,667
Σ	Σ			1,590		0	7,584,707
				e=	0.0		0
				I=			7,584,707

Iz= 0.07584707 m4

b1	1800	t1	27
b2	2500	t2	10
b3	1800	t3	25
bt	2500	t4	10

J= $\fallingdotseq (4 \cdot (b1 \cdot b2)^2)$

0.12683 m^4

G1 18823.3 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	―Flange	2000	16	320	126	40,256	5,064,205
3	―stiff	140	12	50	118	5,947	702,044
2	―Web	2500	9	450	0	0	2,343,750
1	―stiff	140	12	17	-118	-1,982	234,198
1	―Flange	2000	14	280	-126	-35,196	4,424,137
Σ	Σ			1,117		9,025	12,768,334
				e=	8.1		72903
				I=			12,841,236

Iy= 0.12841236 m4

Zu= 0.1091 m^3 σa＝ 181.825 n/mm^2 181,825 Kn/m^2

Zl= -0.0960 m^3 σa＝ 210 n/mm^2= 210,000 Kn/m^2

28.125 σu＝ 172,562

σl＝ -196,098

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	―Web	2000	16	320		0	1,066,667
3	―stiff	140	12	34	45		68,040
1	―Flange	2500	9	225	90	20,250	1,822,500
1	―Flange	2500	9	225	-90	-20,250	1,822,500
1	―stiff	140	12	17	0		0
1	―Web	2000	14	280		0	933,333
Σ	Σ			1,100		0	5,713,040
				e=	0.0		0
				I=			5,713,040

Iz= 0.0571304 m4

b1	1800	t1	16
b2	2500	t2	9
b3	1800	t3	14
bt	2500	t4	9

J= ≒(4･(b1･b2)^2)

0.10168 m^4

G2 -33794 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	—Flange	2000	28	560	126	70,784	8,947,098
1	—stiff	140	12	17	118	1,982	234,198
2	—Web	2500	10	500	0	0	2,604,167
3	—stiff	140	12	50	-118	-5,947	702,044
1	—Flange	2000	28	560	-126	-70,784	8,947,098
Σ	Σ			1,687		-3,965	21,434,603
				e=	-2.3		9317
				I=			21,443,920

Iy= 0.2144392 m4

Zu= 0.1666 m^3 σa＝ 210 n/mm^2 210,000 Kn/m^2

Zl= -0.1729 m^3 σa＝ 210 n/mm^2 210,000 Kn/m^2

σu＝ −202,901

σl＝ 195,494

		Width/H	Thickne	Area	X cm	AX cm3	AX^2+I0
1	—Web	2000	28	560		0	1,866,667
1	—stiff	140	12	17	*0*	0	0
1	—Flange	2500	10	250	90	22,500	2,025,000
1	—Flange	2500	10	250	-90	-22,500	2,025,000
3	—stiff	140	12	34	45		68,040
1	—Web	2000	28	560	0	0	1,866,667
Σ	Σ			1,670		0	7,851,373
				e=	0.0		0
				I=			7,851,373

Iz= 0.07851373 m4

b1	1800	t1	28
b2	2500	t2	10
b3	1800	t3	28
bt	2500	t4	10

J= $\fallingdotseq (4\cdot(b1\cdot b2)^2)$

0.12886 m^4

G2 20600 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	―Flange	2000	17	340	126	42,789	5,384,996
3	―stiff	140	12	50	118	5,947	702,044
2	―Web	2500	9	450	0	0	2,343,750
1	―stiff	140	12	17	-118	-1,982	234,198
1	―Flange	2000	15	300	-126	-37,725	4,743,919
Σ	Σ			1,157		9,029	13,408,906
				e=	7.8		70445
				I=			13,479,351

Iy= 0.13479351 m4

Zu= 0.1142 m^3 σa＝ 189.4353 n/mm^2 189,435 Kn/m^2

Zl= -0.1009 m^3 σa＝ 210 n/mm^2 210,000 Kn/m^2

26.471 σu＝ 180,408

σl＝ -204,103

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	―Web	2000	17	340		0	1,133,333
3	―stiff	140	12	34	45		68,040
1	―Flange	2500	9	225	90	20,250	1,822,500
1	―stiff	140	12	17	0		0
1	―Web	2000	15	300		0	1,000,000
Σ	Σ			1,140		0	5,846,373
				e=	0.0		0
				I=			5,846,373

Iz= 0.05846373 m4

b1	1800	t1	17
b2	2500	t2	9
b3	1800	t3	15
bt	2500	t4	9

J= ≒(4・(b1・b2)^2)

0.10366 m^4

G3 -32176 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	—Flange	2000	27	540	126	68,229	8,620,734
1	—stiff	140	12	17	118	1,982	234,198
2	—Web	2500	10	500	0	0	2,604,167
3	—stiff	140	12	50	-118	-5,947	702,044
1	—Flange	2000	27	540	-126	-68,229	8,620,734
Σ	Σ			1,647		-3,965	20,781,877
				e=	-2.4		9543
				I=			20,791,420

Iy= 0.2079142 m4

Zu= 0.1615 m^3 σa＝ 210 n/mm^2 210,000 Kn/m^2

Zl= -0.1677 m^3 σa＝ 210 n/mm^2 210,000

σu＝ −199,259

σl＝ 191,809

		Width/H	Thickne	Area	X cm	AX cm3	AX^2+I0
1	—Web	2000	27	540		0	1,800,000
1	—stiff	140	12	17		0	0
1	—Flange	2500	10	250	90	22,500	2,025,000
1	—Flange	2500	10	250	-90	-22,500	2,025,000
3	—stiff	140	12	34	45		68,040
1	—Web	2000	27	540	0	0	1,800,000
Σ	Σ			1,630		0	7,718,040
				e=	0.0		0
				I=			7,718,040

Iy= 0.0771804 m4

b1	1800	t1	27
b2	2500	t2	10
b3	1800	t3	27
bt	2500	t4	10

J= $\fallingdotseq (4 \cdot (b1 \cdot b2)^2)$

0.12789 m^4

G3 18067.8 Kn-M

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	—Flange	2000	16	320	126	40,256	5,064,205
3	—stiff	140	12	50	118	5,947	702,044
2	—Web	2500	9	450	0	0	2,343,750
1	—stiff	140	12	17	-118	-1,982	234,198
1	—Flange	2000	14	280	-126	-35,196	4,424,137
Σ	Σ			1,117		9,025	12,768,334
				e=	8.1		72903
				I=			12,841,236

Iy= 0.12841236 m4

Zu= 0.1091 m^3 σa= 181.825 n/mm^2 181,825 Kn/m^2

Zl= -0.0960 m^3 σa= 210 n/mm^2 210,000

28.125 σu= 165,636

σl= -188,228

		Width/H	Thickne	Area	y cm	Ay cm3	Ay^2+I0
1	—Web	2000	16	320		0	1,066,667
3	—stiff	140	12	34	45		68,040
1	—Flange	2500	9	225	90	20,250	1,822,500
1	—Flange	2500	9	225	-90	-20,250	1,822,500
1	—stiff	140	12	17	0		0
1	—Web	2000	14	280		0	933,333
Σ	Σ			1,100		0	5,713,040
				e=	0.0		0
				I=			5,713,040

Iy= 0.0571304 m4

b1	1800	t1	16
b2	2500	t2	9
b3	1800	t3	14
bt	2500	t4	9

J= $\fallingdotseq (4\cdot(b1\cdot b2)^2)$

0.10168 m^4

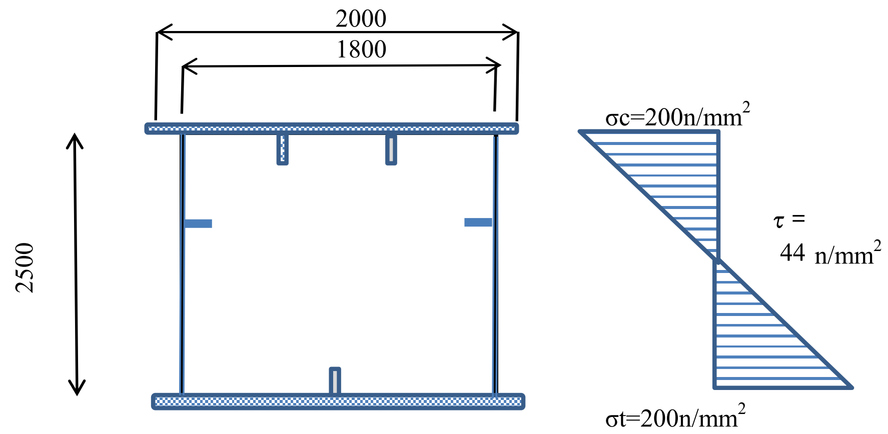
表−4. 2. 5　補剛板の局部座屈に対する許容応力度（N/mm^2）

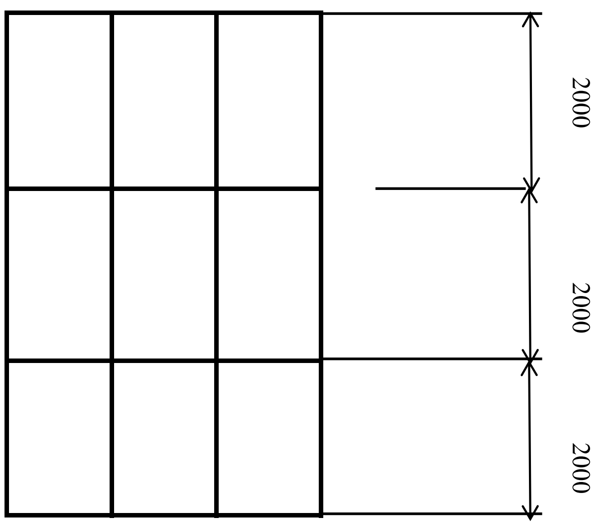
鋼種 / 板厚(mm)	SS400 SM400 SMA400W	SM490	SM490Y SM520 SMA490W	SM570 SMA570W
40以下	$140: \frac{b}{28fn} \leqq t$ $140-2.6\left(\frac{b}{tfn}-28\right): \frac{b}{56fn} \leqq t < \frac{b}{28fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{56fn}$	$185: \frac{b}{24fn} \leqq t$ $185-3.9\left(\frac{b}{tfn}-24\right): \frac{b}{48fn} \leqq t < \frac{b}{24fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{48fn}$	$210: \frac{b}{22fn} \leqq t$ $210-4.6\left(\frac{b}{tfn}-22\right): \frac{b}{46fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{46fn}$	$255: \frac{b}{22fn} \leqq t$ $255-6.9\left(\frac{b}{tfn}-22\right): \frac{b}{40fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{40fn}$
40を超え75以下	$125: \frac{b}{28fn} \leqq t$ $125-2.1\left(\frac{b}{tfn}-28\right): \frac{b}{58fn} \leqq t < \frac{b}{28fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{58fn}$	$175: \frac{b}{24fn} \leqq t$ $175-3.5\left(\frac{b}{tfn}-24\right): \frac{b}{50fn} \leqq t < \frac{b}{24fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{50fn}$	$195: \frac{b}{22fn} \leqq t$ $195-4.0\left(\frac{b}{tfn}-22\right): \frac{b}{46fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{46fn}$	$245: \frac{b}{22fn} \leqq t$ $245-6.2\left(\frac{b}{tfn}-22\right): \frac{b}{42fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{42fn}$
75を超え100以下			$190: \frac{b}{22fn} \leqq t$ $190-3.7\left(\frac{b}{tfn}-22\right): \frac{b}{48fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{48fn}$	$240: \frac{b}{22fn} \leqq t$ $240-6.0\left(\frac{b}{tfn}-22\right): \frac{b}{42fn} \leqq t < \frac{b}{22fn}$ $210,000\left(\frac{tfn}{b}\right)^2: \frac{b}{80fn} \leqq t < \frac{b}{42fn}$

b=	1800	1800
n=	5	4
f=	1	1
b/28fn=	12.9	16.1
b/22fn=	16.4	20.5

Design Condition

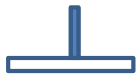
Width of Flange	W=	2200 mm		a=	2000 mm						
Distance of both webs	w=	2000 mm		b=	1800 mm						
Thickness of Flange	tf=	25 mm		n=	4						
Space of Cross beam	a=	2000 mm	Tentative	f=	1.0						
Thickness of Web plate	tw=	9 mm		t=	25	SM490Y	210	22	46	4.6	
Sheraing Force of girder	S=	1980 Kn		Io= $bt^3/11$=	2,556,818						





to=b/(22fn)=	20.4545	<t
b/(46fn)=	9.78261	<t
b/(tfn)=	18	
4.6(b/(tfn)-28)=	-18.4	

σcal＝	210	N/mm^2



hr	210	mm
tr	19	mm

Il= $hr^3 \cdot tr/3$=		58,653,000	mm^4
Al= hr・tr	=	3,990	mm^2
>	bt/10n	1,125	mm^2
δ_l =Al/ bt=		0.0887	
$n \cdot \delta_l$	=	0.3547	
γl= $Ii/(bt^3/11)$=		22.9	
(1+nγl)=		92.8	
$\sqrt{(1+n\gamma l)}$=		9.63	
α0= $\sqrt[4]{(1+n\gamma l)}$=		3.10	
α= a/b=		1.1 <	α0

① $$\gamma_{l,req.} = 4\alpha^2 n \left(\frac{t_0}{t}\right)^2 (1+n\delta_l) - \frac{(\alpha^2+1)^2}{n} \quad (t \geqq t_0) \quad (R_R < 0.5)$$

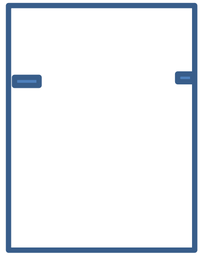
② $$= 4\alpha^2 n (1+n\delta_l) - \frac{(\alpha^2+1)}{n} \quad (t < t_0) \quad (R_R > 0.5)$$

①	γlreq＝	16.66462	Io・γlreq＝	42,608,414	1.377
②	γlreq＝	26.20021	Io・γlreq＝	66,989,162	N.A

鋼種 / 板厚 (mm)	SS400 SM400 SMA400W	SM490	SM490Y SM520 SMA490W	SM570 SMA570W
40以下	$140:\dfrac{b}{28fn}\leqq t$ $140-2.6\left(\dfrac{b}{tfn}-28\right):$ $\dfrac{b}{56fn}\leqq t<\dfrac{b}{28fn}$	$185:\dfrac{b}{24fn}\leqq t$ $185-3.9\left(\dfrac{b}{tfn}-24\right):$ $\dfrac{b}{48fn}\leqq t<\dfrac{b}{24fn}$	$210:\dfrac{b}{22fn}\leqq t$ $210-4.6\left(\dfrac{b}{tfn}-22\right):$ $\dfrac{b}{46fn}\leqq t<\dfrac{b}{22fn}$	$255:\dfrac{b}{22fn}\leqq t$ $255-6.9\left(\dfrac{b}{tfn}-22\right):$ $\dfrac{b}{40fn}\leqq t<\dfrac{b}{22fn}$
	$210,000\left(\dfrac{tfn}{b}\right)^2:$ $\dfrac{b}{80fn}\leqq t<\dfrac{b}{56fn}$	$210,000\left(\dfrac{tfn}{b}\right)^2:$ $\dfrac{b}{80fn}\leqq t<\dfrac{b}{48fn}$	$210,000\left(\dfrac{tfn}{b}\right)^2:$ $\dfrac{b}{80fn}\leqq t<\dfrac{b}{46fn}$	$210,000\left(\dfrac{tfn}{b}\right)^2:$ $\dfrac{b}{80fn}\leqq t<\dfrac{b}{40fn}$

$$\left(\frac{b}{100t}\right)^4 \left[\left(\frac{\sigma}{900}\right)^2 + \left\{\frac{\tau}{120 + 58(b/a)^2}\right\}^2\right] \le 1 : \left(\frac{a}{b} > 0.80\right)$$

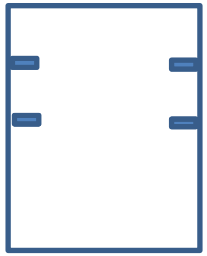
$$\left(\frac{b}{100t}\right)^4 \left[\left(\frac{\sigma}{900}\right)^2 + \left\{\frac{\tau}{90 + 77(b/a)^2}\right\}^2\right] \le 1 : \left(\frac{a}{b} \le 0.80\right)$$



900	120	58	16.000	0.049	0.079	**2.053**
900	90	77	16.000	0.049	0.090	**2.224**

$$\left(\frac{b}{100t}\right)^4 \left[\left(\frac{\sigma}{3,000}\right)^2 + \left\{\frac{\tau}{187 + 58(b/a)^2}\right\}^2\right] \le 1 : \left(\frac{a}{b} > 0.64\right)$$

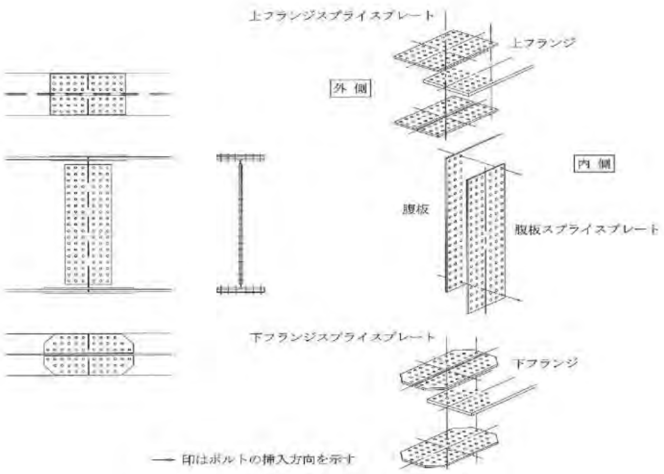
$$\left(\frac{b}{100t}\right)^4 \left[\left(\frac{\sigma}{3,000}\right)^2 + \left\{\frac{\tau}{140 + 77(b/a)^2}\right\}^2\right] \le 1 : \left(\frac{a}{b} \le 0.64\right)$$

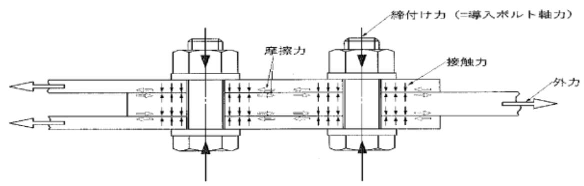


3000	187	58	16.000	0.004	0.042	*0.738*
3000	140	77	16.000	0.004	0.053	*0.921*

t	10	mm
a	2000	mm
b	2000	mm
a/b	1.0	
σ	200	
τ	50	

bt3/11	181,818	
30*a/b	30	
Ih.req	5,454,545	mm^4
t=	120	
b=	10	
b^3t/3=	11,250,000	


上フランジスプライスプレート
上フランジ
外 側
内 側
腹板
腹板スプライスプレート
下フランジスプライスプレート
下フランジ
— 印はボルトの挿入方向を示す


締付け力（=導入ボルト軸力）
摩擦力
接触力
外力
図 1.1 摩 擦 接 合

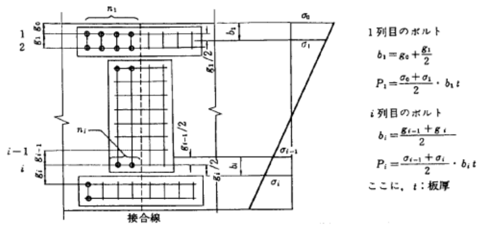
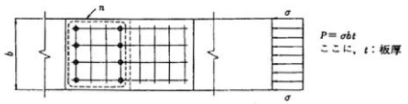


図-7.3.1　ボルトに作用する力（垂直応力の分布が均等でない場合）



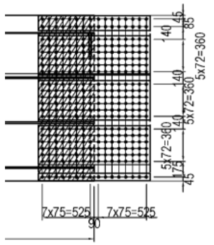
$$\rho_s = S/n \leq \rho_a$$

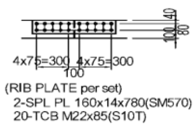
$$\rho = \sqrt{\rho_p^2 + \rho_s^2} \leq \rho_a$$

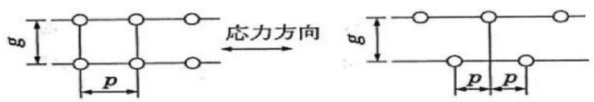
Joint Force:F
F= σf＊Af

Required numbers of Bolts
n= F/ρ

ρ Is unit resistance friction force relating to single friction or double friction and surface treatment.







Stres directiom

stress direction

Minimum Spacing

表-7.3.2　ボルトの最小中心間隔（mm）

ボルトの呼び	最小中心間隔
M24	85
M22	75
M20	65

Maximum Spacing

表-7.3.3　ボルトの最大中心間隔　（mm）

ボルトの呼び	最大中心間隔		
	p		g
M24	170	12t 千鳥の場合は，15t−3/8・g ただし，12t 以下	24t ただし，300 以下
M22	150		
M20	130		

表-3.2.7　摩擦接合用高力ボルトの許容力
（1ボルト1摩擦面あたり）

(a)　接触面を塗装しない場合　(kN)

ボルトの等級 / ねじの呼び	F8T	F10T	S10T
M20	31	39	39
M22	39	48	48
M24	45	56	56

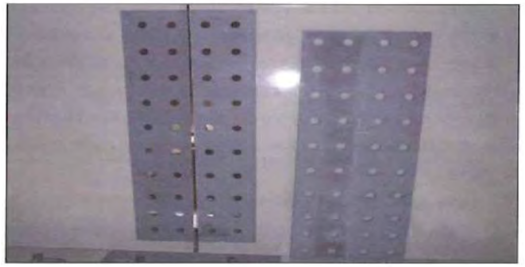
(b)　接触面に無機ジンクリッチペイントを塗布する場合

(kN)

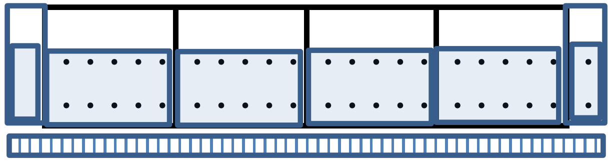
ボルトの等級 / ねじの呼び	F8T	F10T	S10T
M20	35	44	44
M22	44	54	54
M24	51	63	63

In case of the below condition
*Surface is not painted
*Single contact surface
*If double contact surface is effective,
the restance force is 2-times.

In case of the below condition
*Surface is painted by non-organic Zinc-Rich
*Single contact surface
*If double contact surface is effective,
the restance force is 2-times.

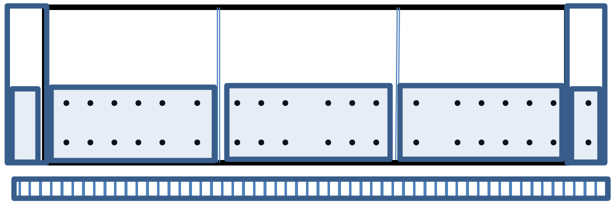


			J1	J2	J3	J4
Position						
U-Flange	Width	mm	2000	2000	2000	2000
	Thickness	mm	16	22	32	22
	Area	cm2	320	440	640	440
			SM400	SM400	SM490	SM490
	0.75σa	N/mm2	105	105	157.5	157.5
	0.75σca	N/mm2	105	105	150	150
	σf	N/mm2	90	110	180	120
Joint Force		KN	3360	4840	11520	6600
Nreq	ρa=96KN		35.0	50.4	120.0	68.8
	Ng		22	22	22	23
	Np		2	3	6	3
			200+4@450	200+4@450	200+4@450	200+2@900
LF-lange	Width		2000	2000	2000	2000
	Thickness		16	22	34	25
	Area		320	440	680	500
			SM400	SM400	SM490	SM490
	0.75σa		105	105	157.5	157.5
	0.75σca		105	105	150	150
	σf		90	110	190	135
Joint Force			3360	4840	12920	7500
Nreq	ρa=96KN		35.0	50.4	134.6	78.1
	Ng		23	23	23	22
	Np		2	3	6	4
			200+2@900	200+2@900	200+2@900	200+4@450



65+4@80+65=

450 450 450 450



60+6@80+60=

600 600 600

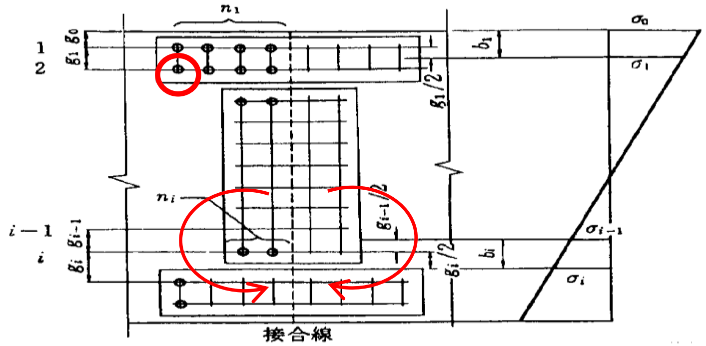
Splice plate

External		1-plate	2000x ts1	(ts1 = α・tf/2)
		2-plates	80 x ts2	(ts2=1.2・α・tf/2)
Internal	comp	4-plates	430xts3	(ts3 ＞ α・tf/2・(450/430)
	tens	3-plates	560xts3	(ts3 ＞ α・tf/2・(600/560)

α : Net width factor (W/(W-n・w))
（Tenssion side only）

Moreover splicejoint of stiffener is requreied.

			J1	J2	J3	J4
Position						
Web	Height	mm	2500	2500	2500	2500
	Moment Plate	mm	250	250	250	250
	Thickness	mm	9	9	9	10
	Monet PL	cm2	22.5	22.5	22.5	25
	Total Area	cm2	225	225	225	250
			SM400	SM400	SM490	SM490
	σf	N/mm2	90	110	180	120
Joint Axial Force F		KN	182.25	222.75	364.5	270
Joint ShearForce(2-we		KN	3000	2000	1000	3000
ρa=	96	KN				
Mom	Nm		1.86	2.27	3.72	2.76
Shear	Ns		15.31	10.20	5.10	15.31
			2@2=4	**2@2=4**	**2@2=4**	**2@2=4**
			"2@10=20	"2@10=20	"2@10=20	"2@10=20
	ρm=		45.6	55.7	91.1	67.5
	ρs=		62.5	41.7	20.8	62.5
	SQR(ρm²+ρs²)		77.3	69.6	93.5	92.0



g0=100
g1=100
150

"9@200=
1800
150
g1=100
g0=100

1st Raw

$$b_1 = g_0 + \frac{g_1}{2}$$

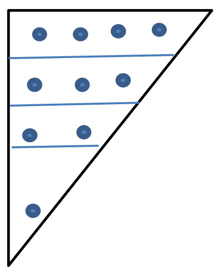
$$P_1 = \frac{\sigma_0 + \sigma_1}{2} \cdot b_1 t$$

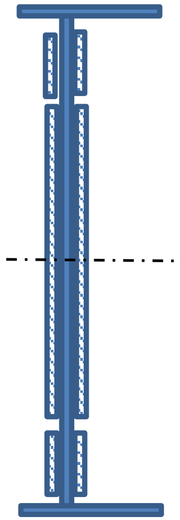
i-Raw

$$b_i = \frac{g_{i-1} + g_i}{2}$$

$$P_i = \frac{\sigma_{i-1} + \sigma_i}{2} \cdot b_i t$$

ここに、 t ：板厚





2-plates
180 x t5

2-plates
1880 x t4

(2-plate)
2420 x t4'

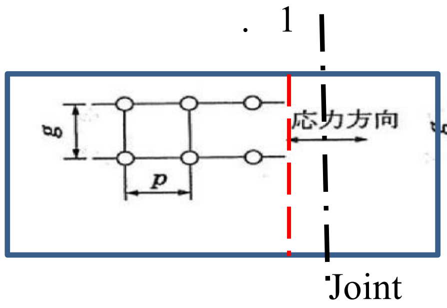
2-plates
180 x t5

I w= 1/12・hw³・tw < Is

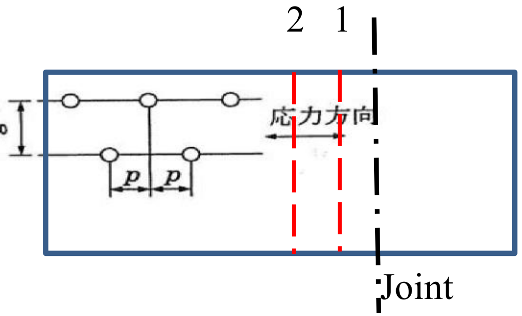
Is= 1/12・hs³・t4' ・2

- A(gap)・ys²

Net Width of Splice Plate



Parallel Arrangemnet



Diagonal Arrangemnet

Reduction width/ 1-bolt doue to 2nd line

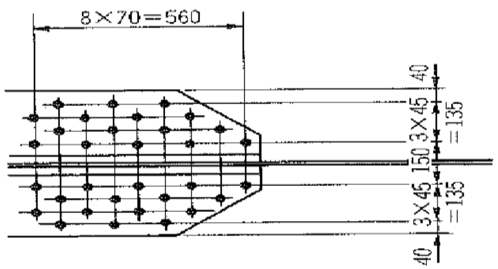
$$w = d - \frac{p^2}{4g} \quad \text{(mm)}$$

d= 24.5mm(in case of M22)

Examle:

p=75/2＝	37.5	45
g=	75	75
$p^2/4g$=	4.69	6.75
w=	19.81	17.75

Net width of tenssion side Wf*=Wf-n1・d-n2・w



1－PL 500×19 95.0－(4×2.5＋0×W)×1.9
＝76.0 cm²

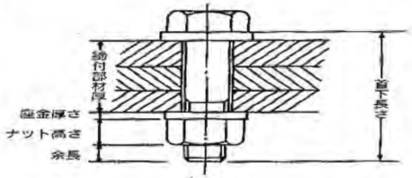
2－PL 215×21 90.3－(4×2.5＋0×W)×2.1
＝69.3 cm²

AN 合計 ＝145.3 cm²

σ_t＝2 089×144.00/145.3
＝2 070 kgf/cm²＜2 100 kgf/cm²

ボルトの呼び	M16		M20		M22		M24	
ナット質量 kg/個	0.057		0.097		0.137		0.201	
座金質量 kg/2枚	0.040		0.064		0.104		0.124	
首下長さ mm ＼ 質量 kg	ボルト	セット	ボルト	セット	ボルト	セット	ボルト	セット
30								
35								
40	0.105	0.202						
45	0.113	0.210	0.187	0.348	0.240	0.481		
50	0.120	0.217	0.200	0.361	0.255	0.496	0.323	0.648
55	0.128	0.225	0.212	0.373	0.269	0.510	0.341	0.666
60	0.136	0.233	0.224	0.385	0.284	0.525	0.358	0.683
65	0.144	0.241	0.237	0.398	0.299	0.540	0.376	0.701
70	0.152	0.249	0.249	0.410	0.314	0.555	0.394	0.719
75	0.160	0.257	0.261	0.422	0.329	0.570	0.412	0.737
80	0.168	0.265	0.274	0.435	0.344	0.585	0.429	0.754
85	0.176	0.273	0.286	0.447	0.359	0.600	0.447	0.772
90	0.184	0.281	0.298	0.459	0.374	0.615	0.465	0.790
95	0.192	0.289	0.311	0.472	0.389	0.630	0.483	0.808
100	0.199	0.296	0.323	0.484	0.404	0.645	0.500	0.825
105	0.207	0.304	0.335	0.496	0.418	0.659	0.518	0.843
110	0.215	0.312	0.348	0.509	0.433	0.674	0.536	0.861
115	0.223	0.320	0.360	0.521	0.448	0.689	0.554	0.879
120	0.231	0.328	0.372	0.533	0.463	0.704	0.571	0.896
125			0.385	0.546	0.478	0.719	0.589	0.914
130			0.397	0.558	0.493	0.734	0.607	0.932
135			0.409	0.570	0.508	0.749	0.625	0.950
140			0.422	0.583	0.523	0.764	0.642	0.967
145					0.538	0.779	0.660	0.985
150					0.553	0.794	0.678	1.003
155					0.567	0.808	0.696	1.021
160					0.582	0.823	0.713	1.038
165							0.731	1.056
170							0.749	1.074
175							0.767	1.092
180							0.784	1.109
185							0.802	1.127
190								

screw part.



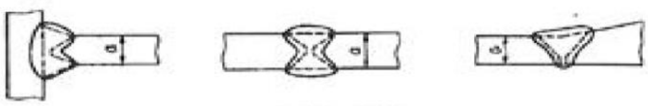
単位：mm

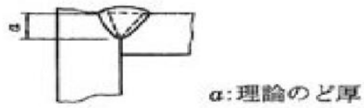
呼び(d)	締付け長さに加える値	最大余長	最小余長
M16	30	9	5
M20	35	10	6
M22	40	10	6
M24	45	13	9
M27	50	15	11
M30	55	13	9
M33	60	15	11
M36	65	17	13

注）最大余長は5mm単位に切り上げた場合の値を示す。（施主により異なる場合もある。）

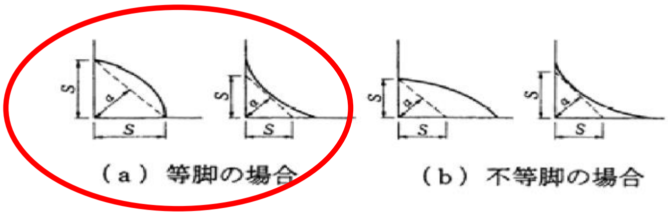
Welding Joint Type

Butt Weld (Full Penetration)　　　　　　　Partial Butt Weld

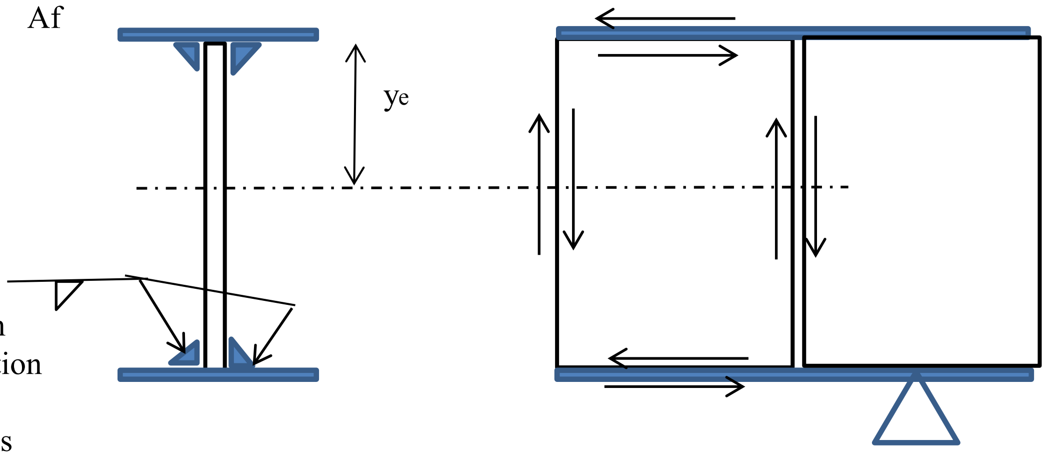




Fillet Weld



Shear Flow at the position of Bearing Support



s=8mm
assumption

a=o.707s

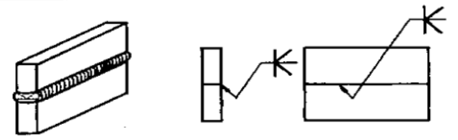
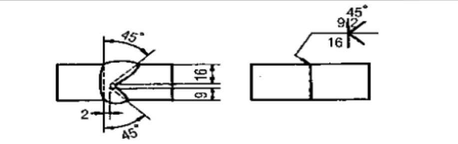
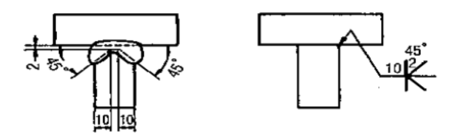
q=S･Q/I

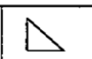
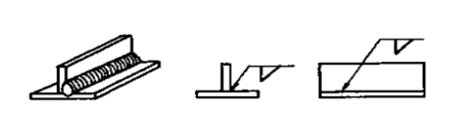
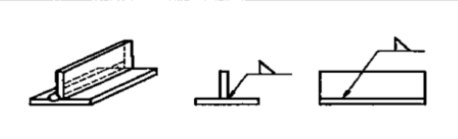
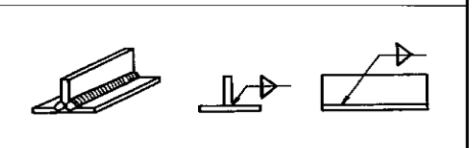
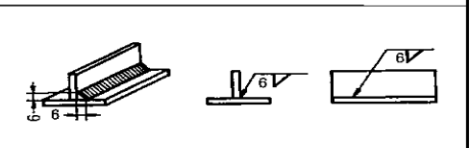
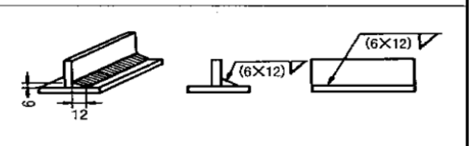
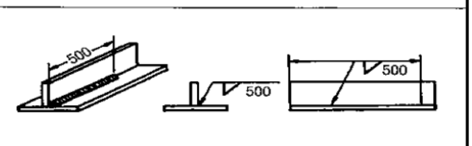
Q=Af･ ye　　　　ye ≒H/2

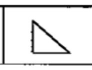
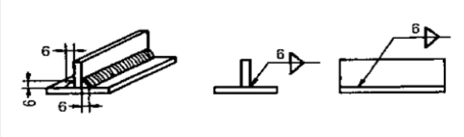
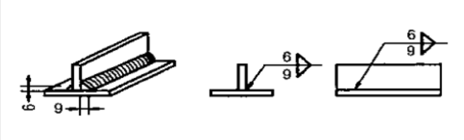
τ=q/4a　　　　Weld Lines between flange and we are 4.

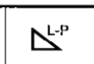
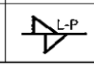
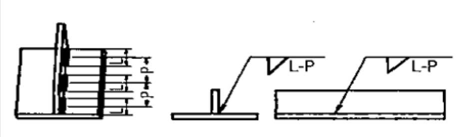
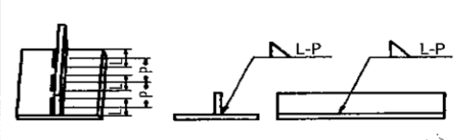
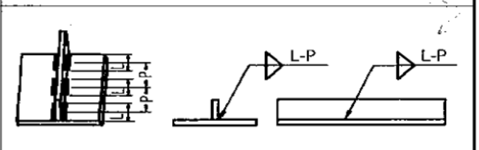
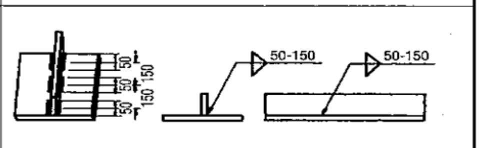
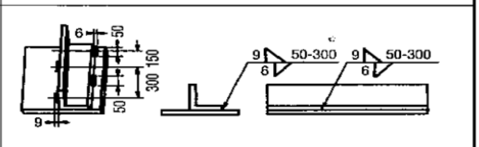
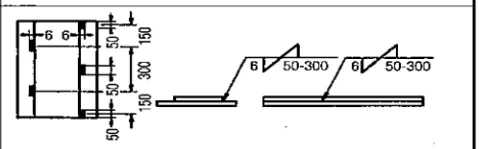
			J1	J2	J3
Af	cm		200	200	200
	cm		3.2	2	1.6
	cm^2		640	400	320
ye	cm		125	125	125
I	cm^4		2.6E+07	1.7E+07	1.4E+07
S	Kn		7000	3000	5000
q=S･Q/I	Kn/cm		21.26	8.65	13.94
s	mm		7.00	6.00	6.00
τ=q/4a	N/mm^2		43.4	20.6	33.2

Indication o

K形グループ溶接	記号 K	レ形グループ溶接記号を基線に対称に書く
溶接部	実形	図示
両側		
矢の側 開先深さ16mm 開先角度45度 矢の反対側 開先深さ 9 mm 開先角度45度 ルート間隔 2 mm の場合	 	
T継手 開先深さ10mm 開先角度45度 ルート間隔 2 mm の場合	 	

すみ肉溶接	連続 (1)	記号 	直角二等辺三角形と書く
溶接部	実形	図示	
矢の側 または 手前側			
矢の反対側 または 向側			
両側			
脚長 6 mm の場合	 		
不等脚の場合，小さい脚の寸法を先に，大きい脚を後に書き，かっこでくくる。 断面の表示が可能な場合は不等脚の方向がわかるように記入する。	 		
溶接長さ 500mm の場合	 		

すみ肉溶接	連続 (2)	記号 	直角二等辺三角形と書く
溶接部	実形	図示	
両側脚長 6 mm の場合	 		
両側脚長の 異なる場合	 		

すみ肉溶接	断続	記号	並列 	直角二等辺三角形で L（溶接長さ）と P（ピッチ）を記入する
			千鳥 	両側のすみ肉が等しい場合は  の記号を用いてもよい
溶接部	実形	図示		
矢の側 または 手前側	 			
矢の反対側 または 向側	 			
両側	 			
並列溶接 溶接長さ50mm ピッチ150mm の場合	 			
千鳥溶接 手前側脚長6mm 向側脚長9mm 溶接長さ50mm ピッチ300mm の場合	 			
千鳥溶接 両側脚長 6 mm 溶接長さ50mm ピッチ300mm の場合	 			

G1														
Sec No.		1	2	3	4	5	6	7	8	9	10	11	12	13
	Length	11750	10000	10000	10000	10000	10000	6500	10000	10000	10000	10000	10000	11750
U.Flang	Width	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
U.Flang	Thickness	14	16	22	22	18	22	28	22	18	22	22	16	14
U.Flang	Dgrade	SM400	SM400	SM490	SM490	SM400	SM490	SM490	SM490	SM400	SM490	SM490	SM400	SM400
U.Longi	Height	190	190	190	190	190	190	190	190	190	190	190	190	190
	Thickness	16	16	16	16	16	16	16	16	16	16	16	16	16
	Quantity	4	4	4	4	4	2	2	2	4	4	4	4	4
L.Flang	Width	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
	Thickness	14	16	19	19	18	22	30	22	18	10	19	16	14
	Dgrade	SM400	SM400	SM490	SM490	SM400	SM490	SM490	SM490	SM400	SM490	SM490	SM400	SM400
L.Longi	Height	190	190	190	190	190	190	190	190	190	190	190	190	190
	Thickness	16	16	16	16	16	16	16	16	16	16	16	16	16
	Quantity	2	2	2	2	2	4	4	4	2	2	2	2	2
Web	Height	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
	Thickness	9	9	9	9	9	9	9	9	9	9	9	9	9
	Quantity	2	2	2	2	2	2	2	2	2	2	2	2	2
	Grade	SM400	SM400	SM490	SM490	SM400	SM490	SM490	SM490	SM400	SM490	SM490	SM400	SM400
H.Stiff	Length	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	Height	120	120	120	120	120	120	120	120	120	120	120	120	120
	Thickness	10	10	10	10	10	10	10	10	10	10	10	10	10
	Quantity	38	32	32	32	32	32	20.8	32	32	32	32	32	38
V.Stiff	Height	150	150	150	150	150	150	150	150	150	150	150	150	150
	Thickness	14	14	14	14	14	14	14	14	14	14	14	14	14
	Length	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
	Quantity	19	16	16	16	16	16	10.4	16	16	16	16	16	18.8
Bearing .Diaphragm	Width	1792						1792						1792
	Thickness	16						22						16
	Height	2500						2500						2500
	Quantity	1						1						1
V.Stiff at bearing	Width	220						220						220
	Thickness	19						22						19
	Height	2500						2500						2500
	Quantity	2						2						2
Stiifenesr for Manh	Height	100						100						100
	Thickness	9						9						9
	Length	900						900						900
	Quantity	4						4						4

Sec No.		1	2	3	4	5	6	7	8	9	10	11	12	13
Mid Diaphragm	Width	1792	1792	1792	1792	1792	1792		1792	1792	1792	1792	1792	1792
	Thickness	9	9	9	9	9	9		9	9	9	9	9	9
	Height	2500	2500	2500	2500	2500	2500		2500	2500	2500	2500	2500	2500
	Quantity	2	2	2	2	2	2	0	2	2	2	2	2	2
Stiifenesr for Manh	Height	100	100	100	100	100	100		100	100	100	100	100	100
	Thickness	9	9	9	9	9	9		9	9	9	9	9	9
	Length	900	900	900	900	900	900		900	900	900	900	900	900
	Quantity	8	8	8	8	8	8		8	8	8	8	8	8
Cross Beam:Web	Height	500	500	500	500	500	500	500	500	500	500	500	500	500
	Thickness	9	9	9	9	9	9	9	9	9	9	9	9	9
	Length	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791
	Quantity	4	4	4	4	4	4	4	4	4	4	4	4	4
Cross Beam:Flg	Height	200	200	200	200	200	200	200	200	200	200	200	200	200
	Thickness	12	12	12	12	12	12	12	12	12	12	12	12	12
	Length	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791	1791
	Quantity	4	4	4	4	4	4	4	4	4	4	4	4	4
Cross Girder:Flg	Width	200	200											
	Thickness	12	12											
	Length	3200	250											
	Quantity	108	216											
Cross Girder:web	Width	1200	1200											
	Thickness	9	9											
	Length	3200	250											
	Quantity	54	108											
		SM400	SM400											

Sec No.			1	2	3	4	5	6	7	8	9	10	11	12	13
Joint	**Decision side**			**1**-2	**2**-3	**3**-4	4-**5**	**5**-6	**6**-7	7-**8**	8-**9**	**9**-10	**10**-**11**	11-**12**	12-**13**
U.Flange															
Required Bolts				40.83	46.67	96.25	52.50	52.50	96.25	96.25	52.50	52.50	96.25	46.67	40.83
Required Columns /each panel				3.41	3.41	3.41	3.41	6.84	6.84	6.84	3.41	3.41	3.41	3.41	3.41
Applied Columns/each Panel				3.00	3.00	3.00	3.00	6.00	6.00	6.00	3.00	3.00	3.00	3.00	3.00
Required Rows				2.72	3.11	6.42	3.50	2.92	5.35	5.35	2.92	3.50	6.42	3.11	2.72
Applied Rows				3.00	4.00	7.00	4.00	3.00	6.00	6.00	3.00	4.00	7.00	4.00	3.00
	External	Width		2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
		Thickness		9	9	11	9	11	14	14	11	9	11	11	9
		Length		470	620	1070	620	470	920	920	470	620	1070	620	470
		Quantity		1	1	1	1	1	1	1	1	1	1	1	1
	External	Width		80	80	80	80	80	80	80	80	80	80	80	80
		Thickness		9	12	12	11	14	16	16	14	11	12	12	9
		Length		470	620	1070	620	470	920	920	470	620	1070	620	470
		Quantity		2	2	2	2	2	2	2	2	2	2	2	2
	internal	Width		310	310	310	310	310	550	550	310	310	310	310	310
		Thickness		10	10	13	11	13	16	16	13	11	13	10	10
		Length		470	620	1070	620	470	920	920	470	620	1070	620	470
		Quantity		5	5	5	5	5	3	3	5	5	5	5	5
	Grade			SM400	SM490	SM490	SM400	SM490	SM490	SM490	SM400	SM490	SM490	SM400	SM400
L.Flang															
Required Bolts				40.83	46.67	83.13	52.50	52.50	64.17	64.17	52.50	52.50	83.13	46.67	40.83
Required Columns /each panel				6.84	6.84	6.84	6.84	6.84	3.41	3.41	4.11	6.84	6.84	6.84	6.84
Applied Columns/each Panel				6.00	6.00	6.00	6.00	6.00	3.00	3.00	4.00	6.00	6.00	6.00	6.00
Required Rows				3.40	3.89	6.93	4.38	4.38	5.35	5.35	6.56	4.38	6.93	3.89	3.40
Applied Rows				4.00	4.00	7.00	5.00	5.00	6.00	6.00	7.00	5.00	7.00	4.00	4.00
	External	Width		2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
		Thickness		9	9	11	9	11	14	14	11	9	11	11	9
		Length		620	620	1070	770	770	920	920	1070	770	1070	620	620
		Quantity		1	1	1	1	1	1	1	1	1	1	1	1
	External	Width		80	80	80	80	80	80	80	80	80	80	80	80
		Thickness		9	12	12	11	14	16	16	14	11	12	12	9
		Length		620	620	1070	770	770	920	920	1070	770	1070	620	620
		Quantity		2	2	2	2	2	2	2	2	2	2	2	2
	internal	Width		550	550	550	550	550	310	310	550	550	550	550	550
		Thickness		10	10	13	11	13	16	16	13	11	13	10	10
		Length		620	620	1070	770	770	920	920	1070	770	1070	620	620
		Quantity		1	1	1	1	1	1	1	1	1	1	1	1
	Grade			SS400	SM490	SM490	SS400	SM490	SM490	SM490	SS400	SM490	SM490	SS400	SS400

Sec No.		1	2	3	4	5	6	7	8	9	10	11	12	13
Web														
Moment Pl	2-Columns	Width	180	180	180	180	180	180	180	180	180	180	180	180
Upper&Lower		Thickness	8	8	8	8	8	8	8	8	8	8	8	8
	3-Rows	Length	470	470	470	470	470	470	470	470	470	470	470	470
		Quantity	4	4	4	4	4	4	4	4	4	4	4	4
Shear Pl	2-Columns	Width	320	320	320	320	320	320	320	320	320	320	320	320
		Thickness	8	8	8	8	8	8	8	8	8	8	8	8
	10-Rows	Length	1880	1880	1880	1880	1880	1880	1880	1880	1880	1880	1880	1880
		Quantity	2	2	2	2	2	2	2	2	2	2	2	2
	Grade		SS400	SS400	SM490	SS400	SM490	SM490	SM490	SS400	SM490	SM490	SS400	SS400
Longi		Width	160	160	160	160	160	160	160	160	160	160	160	160
		Thickness	10	10	10	10	10	10	10	10	10	10	10	10
	Upper	Length	470	620	1070	620	470	920	920	470	620	1070	620	470
		Width	160	160	160	160	160	160	160	160	160	160	160	160
		Thickness	10	10	10	10	10	10	10	10	10	10	10	10
	Lower	Length	620	620	1070	770	770	920	920	1070	770	1070	620	620
			SS400	SS400	SM490	SS400	SM490	SM490	SM490	SS400	SM490	SM490	SS400	SS400

Cross Girder:Spl	Width	200	80											
	Thickness	8	8											
	Length	470	470											
	Quantity	108	216											
	Width	320												
	Thickness	8												
	Length	940												
	Quantity	216												
	Grade	SS400	SS400											

1-Main Girder Only

	Width	Thickness	Length	quantity	Net	Weight	
U.Flang	2000	14	11750	1		2,583	SM400
U.Flang	2000	16	10000	1		2,512	SM400
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	18	10000	1		2,826	SM400
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	28	6500	1		2,857	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	18	10000	1		2,826	SM400
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	16	10000	1		2,512	SM400
U.Flang	2000	14	11750	1		2,583	SM400
U.Longi	190	16	11750	4		1,122	SM400
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	10000	2		477	SM490
U.Longi	190	16	6500	2		310	SM490
U.Longi	190	16	10000	2		477	SM490
U.Longi	190	16	10000	2		477	SM400
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	11750	4		1,122	SM400
L.Flang	2000	14	11750	1		2,583	SM400
L.Flang	2000	16	10000	1		2,512	SM400
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	18	10000	1		2,826	SM400
L.Flang	2000	22	10000	1		3,454	SM490
L.Flang	2000	30	6500	1		3,062	SM490
L.Flang	2000	22	10000	1		3,454	SM490
L.Flang	2000	18	10000	1		2,826	SM400
L.Flang	2000	18	10000	1		2,826	SM490
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	16	10000	1		2,512	SM400
L.Flang	2000	14	11750	1		2,583	SM400
L.Longi	190	16	11750	2		561	SM400
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	4		955	SM490
L.Longi	190	16	6500	4		620	SM490
L.Longi	190	16	10000	4		955	SM490
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	11750	2		561	SM400
Web	2500	9	11750	2		4,151	SM400
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490

	Width	Thickness	Length	quantity	Net	Weight	
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	6500	2		2,296	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	11750	2		4,151	SM400
H.Stiff	120	10	1050	38		372	SM400
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	21		206	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	38		372	SM400
V.Stiff	150	14	2500	19		775	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	10		429	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	19		775	SM400
Bearing .Diaphragm	1792	16	2500	1	0.75	422	SM490
Bearing .Diaphragm	1792	22	2500	1	0.75	580	SM490
Bearing .Diaphragm	1792	16	2500	1		563	SM490
V.Stiff at bearing	220	19	2500	2		164	SM400
V.Stiff at bearing	220	22	2500	2		190	SM400
V.Stiff at bearing	220	19	2500	2		164	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400

	Width	Thickness	Length	quantity	Net	Weight	
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Cross Beam:Web	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
Cross Beam:Flg	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
						165,557	
					3*	496,670	

	Width	Thickness	Length	quantity	Net	Weight	
	200	12	3200	108		6,511	SM400
	200	12	250	216		1,017	SM400
	1200	9	3200	54		14,650	SM400
	1200	9	250	108		2,289	SM400
	2000	9	470	1		66	SM400
	2000	9	620	1		88	SM490
	2000	11	1070	1		185	SM490
	2000	9	620	1		88	SM400
	2000	11	470	1		81	SM490
	2000	14	920	1		202	SM490
	2000	14	920	1		202	SM490
	2000	11	470	1		81	SM400
	2000	9	620	1		88	SM490
	2000	11	1070	1		185	SM490
	2000	11	620	1		107	SM400
	80	9	470	2		5	SM400
	80	12	620	2		9	SM400
	80	12	1070	2		16	SM490
	80	11	620	2		9	SM490
	80	14	470	2		8	SM400
	80	16	920	2		18	SM490
	80	16	920	2		18	SM490
	80	14	470	2		8	SM490
	80	11	620	2		9	SM400
	80	12	1070	2		16	SM490
	310	10	470	5		57	SM490
	310	10	620	5		75	SM400
	310	13	1070	5		169	SM400
	310	11	620	5		83	SM400
	310	13	470	5		74	SM490
	550	16	920	3		191	SM490
	550	16	920	3		191	SM490
	310	13	470	5		74	SM400
	310	11	620	5		83	SM490
	310	13	1070	5		169	SM490
	310	10	620	5		75	SM400
	310	10	470	5		57	SM400
						0	
	2000	9	620	1		88	SS400
	2000	9	620	1		88	SM490
	2000	11	1070	1		185	SM490
	2000	9	770	1		109	SS400
	2000	11	770	1		133	SM490
	2000	14	920	1		202	SM490
	2000	14	920	1		202	SM490
	2000	11	1070	1		185	SS400
	2000	9	770	1		109	SM490
	2000	11	1070	1		185	SM490
	2000	11	620	1		107	SS400
	2000	9	620	1		88	SS400
						0	
	80	9	620	2		7	SS400
	80	12	620	2		9	SM490
	80	12	1070	2		16	SM490
	80	11	770	2		11	SS400
	80	14	770	2		14	SM490
	80	16	920	2		18	SM490
	80	16	920	2		18	SM490

	Width	Thickness	Length	quantity	Net	Weight	
	80	14	1070	2		19	SS400
	80	11	770	2		11	SM490
	80	12	1070	2		16	SM490
	80	12	620	2		9	SS400
	80	9	620	2		7	SS400
						0	
	550	10	620	1		27	SS400
	550	10	620	1		27	SM490
	550	13	1070	1		60	SM490
	550	11	770	1		37	SS400
	550	13	770	1		43	SM490
	310	16	920	1		36	SM490
	310	16	920	1		36	SM490
	550	13	1070	1		60	SS400
	550	11	770	1		37	SM490
	550	13	1070	1		60	SM490
	550	10	620	1		27	SS400
	550	10	620	1		27	SS400
						0	
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SM490
	180	8	470	4		21	SS400
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SS400
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
						0	
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
						0	
	160	10	470	4		24	SS400
	160	10	620	4		31	SS400
	160	10	1070	4		54	SM490
	160	10	620	4		31	SS400
	160	10	470	4		24	SM490
	160	10	920	2		23	SM490
	160	10	920	2		23	SM490
	160	10	470	4		24	SS400
	160	10	620	4		31	SM490
	160	10	1070	4		54	SM490
	160	10	620	4		31	SS400
	160	10	470	4		24	SS400
						0	

	Width	Thickness	Length	quantity	Net	Weight	
	160	10	620	2		16	SS400
	160	10	620	2		16	SS400
	160	10	1070	2		27	SM490
	160	10	770	2		19	SS400
	160	10	770	2		19	SM490
	160	10	920	4		46	SM490
	160	10	920	4		46	SM490
	160	10	1070	2		27	SS400
	160	10	770	2		19	SM490
	160	10	1070	2		27	SM490
	160	10	620	2		16	SS400
	160	10	620	2		16	SS400
						0	
	200	8	470	108		638	SS400
	320	8	940	216		4,080	SS400
	80	8	470	216		510	SS400
						36,623	

Total Plate	533	ton
	5,226	Kn

	Width	Thickness	Length	quantity	Net	Weight	

	Width	Thickness	Length	quantity	Net	Weight	
V.Stiff at bearing	220	22	2500	2		190	SM400
V.Stiff at bearing	220	19	2500	2		164	SM400
V.Stiff at bearing	220	19	2500	2		164	SM400
U.Flang	2000	18	10000	1		2,826	SM400
U.Flang	2000	18	10000	1		2,826	SM400
L.Flang	2000	18	10000	1		2,826	SM400
L.Flang	2000	18	10000	1		2,826	SM400
U.Flang	2000	16	10000	1		2,512	SM400
U.Flang	2000	16	10000	1		2,512	SM400
U.Longi	190	16	11750	4		1,122	SM400
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	10000	2		477	SM400
U.Longi	190	16	10000	4		955	SM400
U.Longi	190	16	11750	4		1,122	SM400
L.Flang	2000	16	10000	1		2,512	SM400
L.Flang	2000	16	10000	1		2,512	SM400
L.Longi	190	16	11750	2		561	SM400
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	10000	2		477	SM400
L.Longi	190	16	11750	2		561	SM400
U.Flang	2000	14	11750	1		2,583	SM400
U.Flang	2000	14	11750	1		2,583	SM400
L.Flang	2000	14	11750	1		2,583	SM400
L.Flang	2000	14	11750	1		2,583	SM400
V.Stiff	150	14	2500	18.8		775	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	10.4		429	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	16		659	SM400
V.Stiff	150	14	2500	18.8		775	SM400
	80	14	470	2		8	SM400
	310	13	1070	5		169	SM400
	310	13	470	5		74	SM400
Cross Beam:Flg	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400
	200	12	1791	4		135	SM400

	Width	Thickness	Length	quantity	Net	Weight	
	200	12	3200	108		6,511	SM400
	200	12	250	216		1,017	SM400
	80	12	620	2		9	SM400
	2000	11	470	1		81	SM400
	2000	11	620	1		107	SM400
	80	11	620	2		9	SM400
	310	11	620	5		83	SM400
H.Stiff	120	10	1050	37.6		372	SM400
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	32		317	SM400
H.Stiff	120	10	1050	37.6		372	SM400
	310	10	620	5		75	SM400
	310	10	620	5		75	SM400
	310	10	470	5		57	SM400
Web	2500	9	11750	2		4,151	SM400
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	10000	2		3,533	SM400
Web	2500	9	11750	2		4,151	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Stiifenesr for Manhole	1792	9	2500	2		633	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Mid Diaphragm	1792	9	2500	2	0.75	475	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Stiifenesr for Manhole	100	9	900	8		51	SM400
Cross Beam:Web	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400
	500	9	1791	4		253	SM400

	Width	Thickness	Length	quantity	Net	Weight	
	500	9	1791	4		253	SM400
	1200	9	3200	54		14,650	SM400
	1200	9	250	108		2,289	SM400
	2000	9	470	1		66	SM400
	2000	9	620	1		88	SM400
	80	9	470	2		5	SM400
L.Flang	2000	30	6500	1		3,062	SM490
U.Flang	2000	28	6500	1		2,857	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
U.Flang	2000	22	10000	1		3,454	SM490
L.Flang	2000	22	10000	1		3,454	SM490
L.Flang	2000	22	10000	1		3,454	SM490
Bearing .Diaphragm	1792	22	2500	1	0.75	580	SM490
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	19	10000	1		2,983	SM490
L.Flang	2000	18	10000	1		2,826	SM490
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	2		477	SM490
U.Longi	190	16	6500	2		310	SM490
U.Longi	190	16	10000	2		477	SM490
U.Longi	190	16	10000	4		955	SM490
U.Longi	190	16	10000	4		955	SM490
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	4		955	SM490
L.Longi	190	16	6500	4		620	SM490
L.Longi	190	16	10000	4		955	SM490
L.Longi	190	16	10000	2		477	SM490
L.Longi	190	16	10000	2		477	SM490
Bearing .Diaphragm	1792	16	2500	1	0.75	422	SM490
Bearing .Diaphragm	1792	16	2500	1		563	SM490
	80	16	920	2		18	SM490
	80	16	920	2		18	SM490
	550	16	920	3		191	SM490
	550	16	920	3		191	SM490
	80	16	920	2		18	SM490
	80	16	920	2		18	SM490
	310	16	920	1		36	SM490
	310	16	920	1		36	SM490
	2000	14	920	1		202	SM490
	2000	14	920	1		202	SM490
	80	14	470	2		8	SM490
	2000	14	920	1		202	SM490
	2000	14	920	1		202	SM490
	80	14	770	2		14	SM490
	310	13	470	5		74	SM490
	310	13	1070	5		169	SM490
	550	13	1070	1		60	SM490
	550	13	770	1		43	SM490
	550	13	1070	1		60	SM490
	80	12	1070	2		16	SM490
	80	12	1070	2		16	SM490

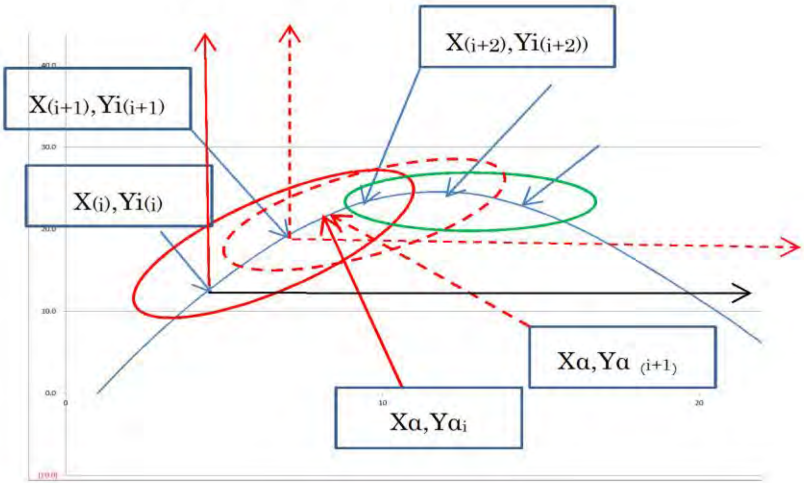
	Width	Thickness	Length	quantity	Net	Weight	
	80	12	620	2		9	SM490
	80	12	1070	2		16	SM490
	80	12	1070	2		16	SM490
	2000	11	1070	1		185	SM490
	2000	11	470	1		81	SM490
	2000	11	1070	1		185	SM490
	80	11	620	2		9	SM490
	310	11	620	5		83	SM490
	2000	11	1070	1		185	SM490
	2000	11	770	1		133	SM490
	2000	11	1070	1		185	SM490
	80	11	770	2		11	SM490
	550	11	770	1		37	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	20.8		206	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
H.Stiff	120	10	1050	32		317	SM490
	310	10	470	5		57	SM490
	550	10	620	1		27	SM490
	160	10	1070	4		54	SM490
	160	10	470	4		24	SM490
	160	10	920	2		23	SM490
	160	10	920	2		23	SM490
	160	10	620	4		31	SM490
	160	10	1070	4		54	SM490
	160	10	1070	2		27	SM490
	160	10	770	2		19	SM490
	160	10	920	4		46	SM490
	160	10	920	4		46	SM490
	160	10	770	2		19	SM490
	160	10	1070	2		27	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	6500	2		2,296	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490
Web	2500	9	10000	2		3,533	SM490
	2000	9	620	1		88	SM490
	2000	9	620	1		88	SM490
	2000	9	620	1		88	SM490
	2000	9	770	1		109	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	180	8	470	4		21	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	320	8	1880	2		76	SM490
	80	14	1070	2		19	SS400

	Width	Thickness	Length	quantity	Net	Weight	
	550	13	1070	1		60	SS400
	80	12	620	2		9	SS400
	2000	11	1070	1		185	SS400
	2000	11	620	1		107	SS400
	80	11	770	2		11	SS400
	550	11	770	1		37	SS400
	550	10	620	1		27	SS400
	550	10	620	1		27	SS400
	550	10	620	1		27	SS400
	160	10	470	4		24	SS400
	160	10	620	4		31	SS400
	160	10	620	4		31	SS400
	160	10	470	4		24	SS400
	160	10	620	4		31	SS400
	160	10	470	4		24	SS400
	160	10	620	2		16	SS400
	160	10	620	2		16	SS400
	160	10	770	2		19	SS400
	160	10	1070	2		27	SS400
	160	10	620	2		16	SS400
	160	10	620	2		16	SS400
	2000	9	620	1		88	SS400
	2000	9	770	1		109	SS400
	2000	9	620	1		88	SS400
	80	9	620	2		7	SS400
	80	9	620	2		7	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	180	8	470	4		21	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	320	8	1880	2		76	SS400
	200	8	470	108		638	SS400
	320	8	940	216		4,080	SS400
	80	8	470	216		510	SS400

Calculation of Camber at each position of vertical stiffeners in accordance with the coordinate of the cross beam position.

- ✓ Camber line should be considered like as parabolic curve which is one of spline curve.
- ✓ Parabolic curve that pass through the 3 points could be defined unambiguously (looks like only one curve

$$Y=a+b*X+c*X^2$$



Coefficient a, b, c can be derived from the following equations

$Yi=ai+bi*Xi+ci*Xi^2$, $Y_{(i+1)}=ai+bi*X_{(i+1)}+ci*X_{(i+1)}{}^2$, $Y_{(i+2)}=ai+bi*X_{(i+2)}+ci*X_{(i+2)}{}^2$

$X_{(i+2)}-X_{(i+1)}= X_{(i+1)} -Xi=\Delta x$ (on sample Calculation, Δx is considered 1)

$ai= \quad Yi$	$a_{(i+1)}= \quad Y_{(i+1)}$
$bi= \quad (-3\,Yi+4\,Y_{(i+1)}-Y_{(i+2)})\ /\ 2$	$b_{(i+1)}= \quad (-3\,Y_{(i+1)}+4\,Y_{(i+2)}-Y_{(i+3)})/\ 2$
$Ci= \quad (Yi-2\,Y_{(i+1)}+Y_{(i+2)}/\ 2$	$C_{(i+1)}= \quad (Y_{(i+1)}-2\,Y_{(i+2)}+Y_{(i+3)})/\ 2$
$Y_{\alpha i}=ai+biX\alpha+CiX\alpha^2$	$Y_{\alpha i}=ai+1+bi_{+1}X\alpha+Ci_{+1}X\alpha^2$

There might be small deviation between $Y\alpha i$ and $Y\alpha i+1$、then the average value would be adopted.

This procedure should be done at the next 3points sequentially.

assumption

(x0,y0)	5200	21.02
(x1,y1)	5335	20.5

0	0
135	-0.52

tan $\alpha =$ -0.00385

$\alpha =$ -0.00385 rad

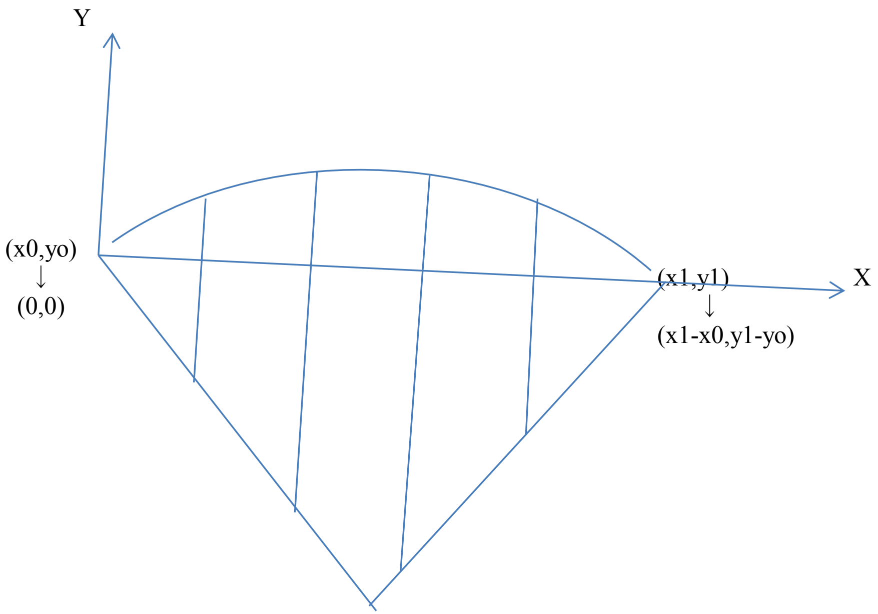
R= 500 m

R・sin $\theta =$ x

$\theta =$ $\sin^{-1}$(x/R)

R・(1-cosθ)= y

x	0	5	10	15	20	25	30	35	40	45	50	55	60	65
x/R	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.11	0.12	0.13
θ	0	0.01	0.020001	0.030005	0.040011	0.050021	0.060036	0.070057	0.080086	0.090122	0.100167	0.110223	0.12029	0.130369
y	0	0.025001	0.10001	0.225051	0.40016	0.625391	0.900811	1.226504	1.602568	2.029117	2.506281	3.034206	3.613054	4.243003
y'	0	0.005742	0.061492	0.167273	0.323124	0.529096	0.785257	1.09169	1.448495	1.855785	2.31369	2.822356	3.381945	3.992635



	END	P12 S1				C1				C2				C3				C4				C5				C6			
	−0.273	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	−400	0	1465.8	2931.5	4397.3	5863.0	7332.3	8801.5	10270.8	11740.0	13209.3	14678.5	16147.8	17617.0	19086.3	20555.5	22024.8	23494.0	24963.3	26432.5	27901.8	29371.0	30840.3	32309.5	33778.8	35248.0	36717.3	38186.5	39655.8
G1	(1.15)	0.00	4.00	7.67	11.01	14.03	16.72	19.09	21.13	22.85	23.87	24.44	24.57	24.25	23.48	22.27	20.61	18.51	16.01	13.57	11.18	8.85	6.58	4.36	2.20	0.10	(1.16)	(1.60)	(1.21)
G1		0.00				14.03	16.93	19.37	21.34	22.85	23.90	24.48	24.60	24.25	23.18	21.87	20.31	18.51	16.46	14.17	11.63	8.85	5.85	3.39	1.48	0.10	(0.74)	(1.03)	(0.79)
G2	(1.02)	0.00	3.55	6.81	9.79	12.48	14.89	17.02	18.86	20.42	21.35	21.88	22.01	21.74	21.07	19.99	18.52	16.64	14.31	12.06	9.88	7.78	5.75	3.79	1.91	0.1	(1.06)	(1.47)	(1.11)
G2		0.00				12.48	15.09	17.28	19.06	20.42	21.37	21.91	22.03	21.74	20.82	19.66	18.27	16.64	14.78	12.68	10.35	7.78	5.15	2.99	1.31	0.1	(0.64)	(0.90)	(0.69)
G3	(0.91)	0.00	3.19	6.13	8.82	11.25	13.43	15.36	17.04	18.47	19.32	19.81	19.94	19.71	19.12	18.17	16.86	15.19	13.12	11.10	9.14	7.23	5.38	3.59	1.85	0.17	(0.91)	(1.30)	(1.00)
G3		0.00				11.25	13.62	15.61	17.23	18.47	19.34	19.84	19.96	19.71	18.90	17.88	16.64	15.19	13.52	11.64	9.54	7.23	4.82	2.84	1.29	0.17	(0.52)	(0.78)	(0.60)

$Y=a+b*X+c*X^2$

X=0、α、2α、3α、4α、・・・・・8α

X i＝ **0**

X i+1 **4α**

X i+2= **8α**

ai＝ Yi

bi＝ （-3 Yi＋4 $Y_{(i+1)}$—$Y_{(i+2)}$） ／8

Ci= (Yi－ 2 $Y_{(i+1)}$＋$Y_{(i+2)}$） ／32

$Y_{\alpha i}$＝ai＋biXα＋CiXα^2

G1	ai	0.00								22.85								18.51								0.10			
	bi	4.1588								1.2425								−2.529								−1.676			
	ci	−0.163								−0.223								0.0284								0.4128			
G1	ai					14.03								24.25								8.85							
	bi					3.1325								−0.945								−3.269							
	ci					−0.232								−0.123								0.2703							
G2	ai	0.00								20.42								16.64								0.10			
	bi	3.6875								1.1325								−2.363								−1.541			
	ci	−0.142								−0.201								0.0369								0.3791			
G2	ai					12.48								21.74								7.78							
	bi					2.8125								−0.805								−2.868							
	ci					−0.207								−0.118								0.2369							
G3	ai	0.00								18.47								15.19								0.17			
	bi	3.3163								1.03								−2.103								−1.426			
	ci	−0.126								−0.18								0.0281								0.3459			
G3	ai					11.25								19.71								7.23							
	bi					2.5525								−0.7								−2.626							
	ci					−0.187								−0.108								0.2153							

P13 S2				C7				C8				C9				C10				C11				
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
41125.0	42560.8	43996.5	45432.3	46868.0	48303.8	49739.5	51175.3	52611.0	54046.8	55482.5	56918.3	58354.0	59789.8	61225.5	62661.3	64097.0	65532.8	66968.5	68404.3	69840.0	######	######	######	75583.0
0.00	2.04	4.90	8.59	13.11	18.30	23.47	28.61	33.73	38.83	43.91	48.96	53.99	58.44	62.32	65.62	68.34	70.49	72.06	73.06	73.48				
0.00	2.57	5.62	9.13	13.11	17.56	22.48	27.87	33.73	39.35	44.60	49.48	53.99	58.13	61.90	65.31	68.34	70.59	72.20	73.16	73.48	73.16	72.20	70.59	68.34
0	1.87	4.50	7.89	12.03	16.72	21.39	26.04	30.67	35.28	39.87	44.45	49.00	53.03	56.54	59.53	62.00	63.95	65.38	66.29	66.68				
0	2.39	5.19	8.40	12.03	16.07	20.52	25.39	30.67	35.75	40.50	44.92	49.00	52.75	56.17	59.25	62.00	64.05	65.51	66.39	66.68	66.39	65.51	64.05	62.00
0	1.69	4.07	7.14	10.9	15.17	19.42	23.65	27.86	32.05	36.22	40.36	44.49	48.14	51.32	54.03	56.26	58.02	59.31	60.13	60.48				
0	2.16	3.94	7.61	10.9	14.57	18.62	23.05	27.86	32.47	36.78	40.79	44.49	47.89	50.98	53.77	56.26	57.92	59.18	60.03	60.48	60.53	60.18	59.42	58.26

				13.11								53.99								
				5.2								4.7388								
				−0.011								−0.288								
0.00								33.73								68.34				
2.3388								5.8038								2.57				
0.2347								−0.185								−0.321				
				12.03								49.00								
				4.6988								4.29								
				−0.01								−0.26								
0								30.67								62				
2.1813								5.2488								2.34				
0.2066								−0.167								−0.293				
				10.90								44.49								
				4.2813								3.8863								
				−0.01								−0.236								
0.00								27.86								56.26				
1.9675								4.765								1.86				
0.1894								−0.152								−0.201				

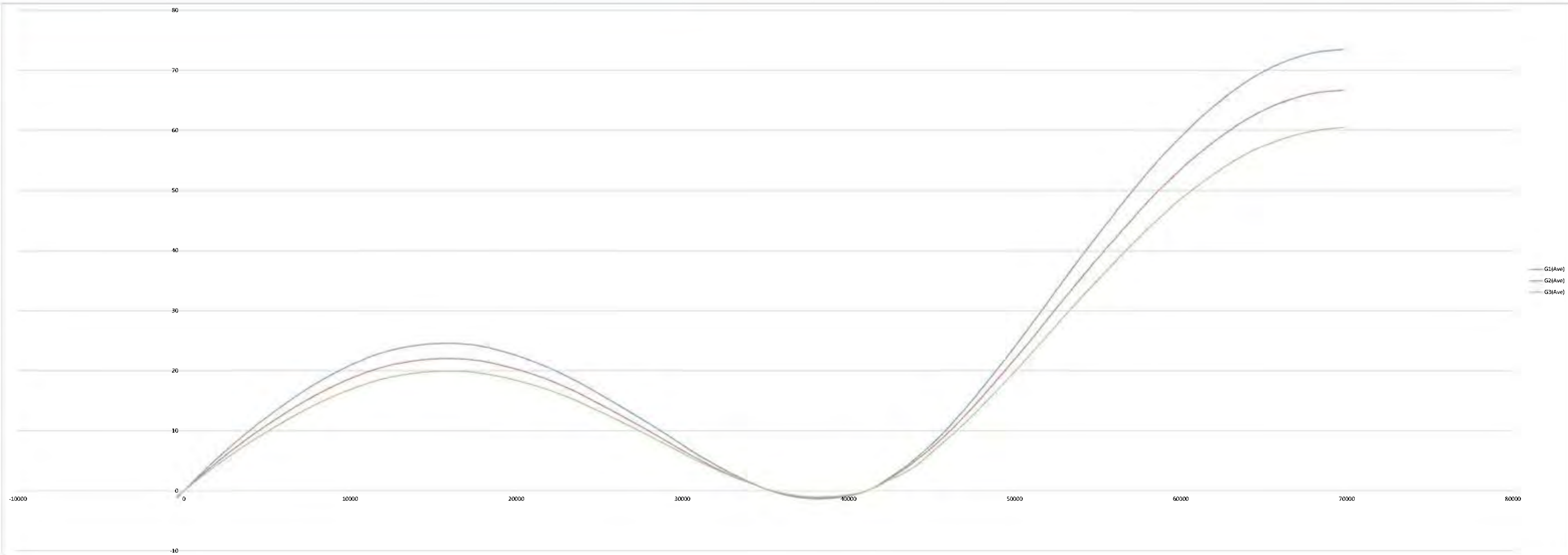
	END	P12 S1				C1				C2				C3				C4
	-0.2729	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
	-400.0	0.0	1465.8	2931.5	4397.3	5863.0	7332.3	8801.5	10270.8	11740.0	13209.3	14678.5	16147.8	17617.0	19086.3	20555.5	22024.8	23494.0
G1	-1.1	0.0	4.0	7.7	11.0	14.0	16.7	19.1	21.1	22.9	23.9	24.4	24.6	24.3	23.5	22.3	20.6	18.5
G1		0.0				14.0	16.9	19.4	21.3	22.9	23.9	24.5	24.6	24.3	23.2	21.9	20.3	18.5
G2	-1.0	0.0	3.5	6.8	9.8	12.5	14.9	17.0	18.9	20.4	21.4	21.9	22.0	21.7	21.1	20.0	18.5	16.6
G2		0.0				12.5	15.1	17.3	19.1	20.4	21.4	21.9	22.0	21.7	20.8	19.7	18.3	16.6
G3	-0.9	0.0	3.2	6.1	8.8	11.3	13.4	15.4	17.0	18.5	19.3	19.8	19.9	19.7	19.1	18.2	16.9	15.2
G3		0.0				11.3	13.6	15.6	17.2	18.5	19.3	19.8	20.0	19.7	18.9	17.9	16.6	15.2
G1(Ave)	-1.1	0.0	4.0	7.7	11.0	14.0	16.8	19.2	21.2	22.9	23.9	24.5	24.6	24.3	23.3	22.1	20.5	18.5
G2(Ave)	-1.0	0.0	3.5	6.8	9.8	12.5	15.0	17.1	19.0	20.4	21.4	21.9	22.0	21.7	20.9	19.8	18.4	16.6
G3(Ave)	-0.9	0.0	3.2	6.1	8.8	11.3	13.5	15.5	17.1	18.5	19.3	19.8	20.0	19.7	19.0	18.0	16.8	15.2

				C5				C6				P13 S2				C7
	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0
	24963.3	26432.5	27901.8	29371.0	30840.3	32309.5	33778.8	35248.0	36717.3	38186.5	39655.8	41125.0	42560.8	43996.5	45432.3	46868.0
G1	16.0	13.6	11.2	8.9	6.6	4.4	2.2	0.1	-1.2	-1.6	-1.2	0.0	2.0	4.9	8.6	13.1
G1	16.5	14.2	11.6	8.9	5.9	3.4	1.5	0.1	-0.7	-1.0	-0.8	0.0	2.6	5.6	9.1	13.1
G2	14.3	12.1	9.9	7.8	5.7	3.8	1.9	0.1	-1.1	-1.5	-1.1	0.0	1.9	4.5	7.9	12.0
G2	14.8	12.7	10.3	7.8	5.1	3.0	1.3	0.1	-0.6	-0.9	-0.7	0.0	2.4	5.2	8.4	12.0
G3	13.1	11.1	9.1	7.2	5.4	3.6	1.9	0.2	-0.9	-1.3	-1.0	0.0	1.7	4.1	7.1	10.9
G3	13.5	11.6	9.5	7.2	4.8	2.8	1.3	0.2	-0.5	-0.8	-0.6	0.0	2.2	3.9	7.6	10.9
G1(Ave)	16.2	13.9	11.4	8.9	6.2	3.9	1.8	0.1	-0.9	-1.3	-1.0	0.0	2.3	5.3	8.9	13.1
G2(Ave)	14.5	12.4	10.1	7.8	5.4	3.4	1.6	0.1	-0.8	-1.2	-0.9	0.0	2.1	4.8	8.1	12.0
G3(Ave)	13.3	11.4	9.3	7.2	5.1	3.2	1.6	0.2	-0.7	-1.0	-0.8	0.0	1.9	4.0	7.4	10.9

				C8				C9				C10				C11
	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0
	48303.8	49739.5	51175.3	52611.0	54046.8	55482.5	56918.3	58354.0	59789.8	61225.5	62661.3	64097.0	65532.8	66968.5	68404.3	69840.0
G1	18.3	23.5	28.6	33.7	38.8	43.9	49.0	54.0	58.4	62.3	65.6	68.3	70.5	72.1	73.1	73.5
G1	17.6	22.5	27.9	33.7	39.3	44.6	49.5	54.0	58.1	61.9	65.3	68.3	70.6	72.2	73.2	73.5
G2	16.7	21.4	26.0	30.7	35.3	39.9	44.4	49.0	53.0	56.5	59.5	62.0	64.0	65.4	66.3	66.7
G2	16.1	20.5	25.4	30.7	35.8	40.5	44.9	49.0	52.7	56.2	59.2	62.0	64.0	65.5	66.4	66.7
G3	15.2	19.4	23.7	27.9	32.0	36.2	40.4	44.5	48.1	51.3	54.0	56.3	58.0	59.3	60.1	60.5
G3	14.6	18.6	23.1	27.9	32.5	36.8	40.8	44.5	47.9	51.0	53.8	56.3	57.9	59.2	60.0	60.5
G1(Ave)	17.9	23.0	28.2	33.7	39.1	44.3	49.2	54.0	58.3	62.1	65.5	68.3	70.5	72.1	73.1	73.5
G2(Ave)	16.4	21.0	25.7	30.7	35.5	40.2	44.7	49.0	52.9	56.4	59.4	62.0	64.0	65.4	66.3	66.7
G3(Ave)	14.9	19.0	23.4	27.9	32.3	36.5	40.6	44.5	48.0	51.2	53.9	56.3	58.0	59.2	60.1	60.5

	P13 S2				C7				C8				C9
	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0
	41125.0	42560.8	43996.5	45432.3	46868.0	48303.8	49739.5	51175.3	52611.0	54046.8	55482.5	56918.3	58354.0
G1	0.0	2.0	4.9	8.6	13.1	18.3	23.5	28.6	33.7	38.8	43.9	49.0	54.0
G1	0.0	2.6	5.6	9.1	13.1	17.6	22.5	27.9	33.7	39.3	44.6	49.5	54.0
G2	0.0	1.9	4.5	7.9	12.0	16.7	21.4	26.0	30.7	35.3	39.9	44.4	49.0
G2	0.0	2.4	5.2	8.4	12.0	16.1	20.5	25.4	30.7	35.8	40.5	44.9	49.0
G3	0.0	1.7	4.1	7.1	10.9	15.2	19.4	23.7	27.9	32.0	36.2	40.4	44.5
G3	0.0	2.2	3.9	7.6	10.9	14.6	18.6	23.1	27.9	32.5	36.8	40.8	44.5
G1(Ave)	0.0	2.3	5.3	8.9	13.1	17.9	23.0	28.2	33.7	39.1	44.3	49.2	54.0
G2(Ave)	0.0	2.1	4.8	8.1	12.0	16.4	21.0	25.7	30.7	35.5	40.2	44.7	49.0
G3(Ave)	0.0	1.9	4.0	7.4	10.9	14.9	19.0	23.4	27.9	32.3	36.5	40.6	44.5

				C10				C11				
	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0
	59789.8	61225.5	62661.3	64097.0	65532.8	66968.5	68404.3	69840.0	71275.8	72711.5	74147.3	75583.0
G1	58.4	62.3	65.6	68.3	70.5	72.1	73.1	73.5				
G1	58.1	61.9	65.3	68.3	70.6	72.2	73.2	73.5	73.2	72.2	70.6	68.3
G2	53.0	56.5	59.5	62.0	64.0	65.4	66.3	66.7				
G2	52.7	56.2	59.2	62.0	64.0	65.5	66.4	66.7	66.4	65.5	64.0	62.0
G3	48.1	51.3	54.0	56.3	58.0	59.3	60.1	60.5				
G3	47.9	51.0	53.8	56.3	57.9	59.2	60.0	60.5	60.5	60.2	59.4	58.3
G1(Ave)	58.3	62.1	65.5	68.3	70.5	72.1	73.1	73.5				
G2(Ave)	52.9	56.4	59.4	62.0	64.0	65.4	66.3	66.7				
G3(Ave)	48.0	51.2	53.9	56.3	58.0	59.2	60.1	60.5				



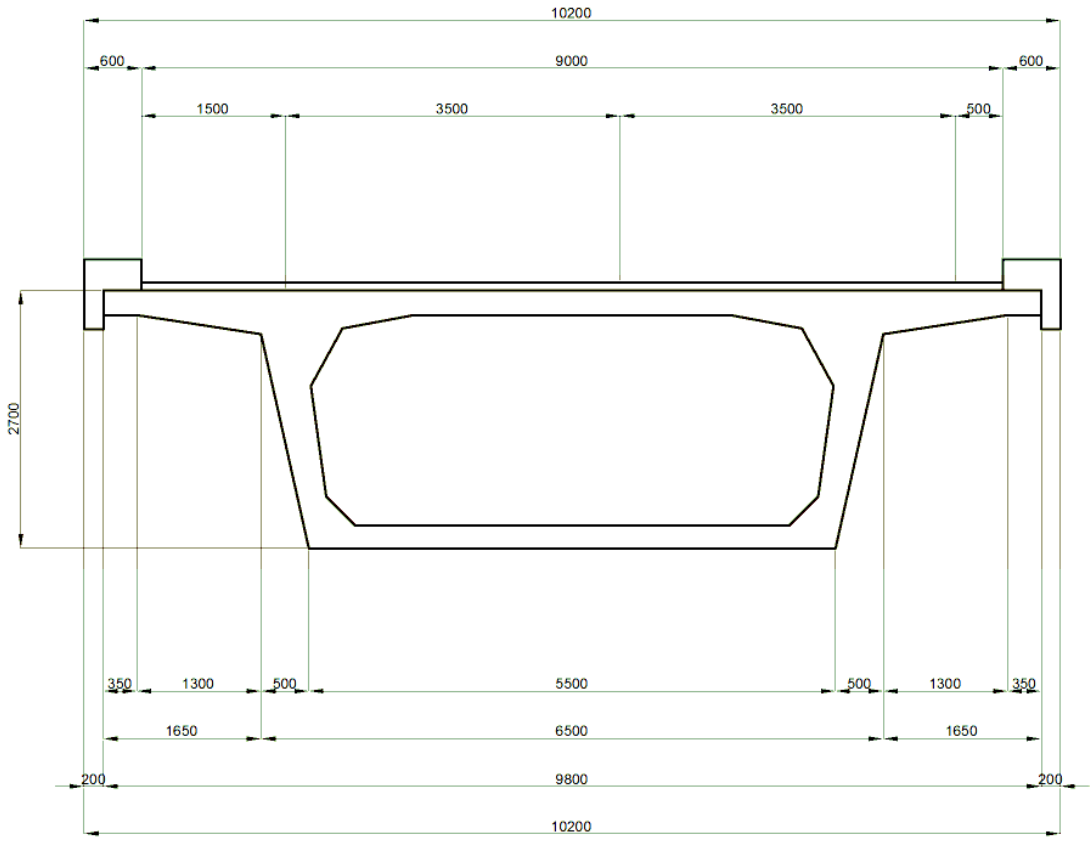
Appendix A Materials of Lectures and Seminars

A-10 Detailed Practice for PC Box Girder Bridge

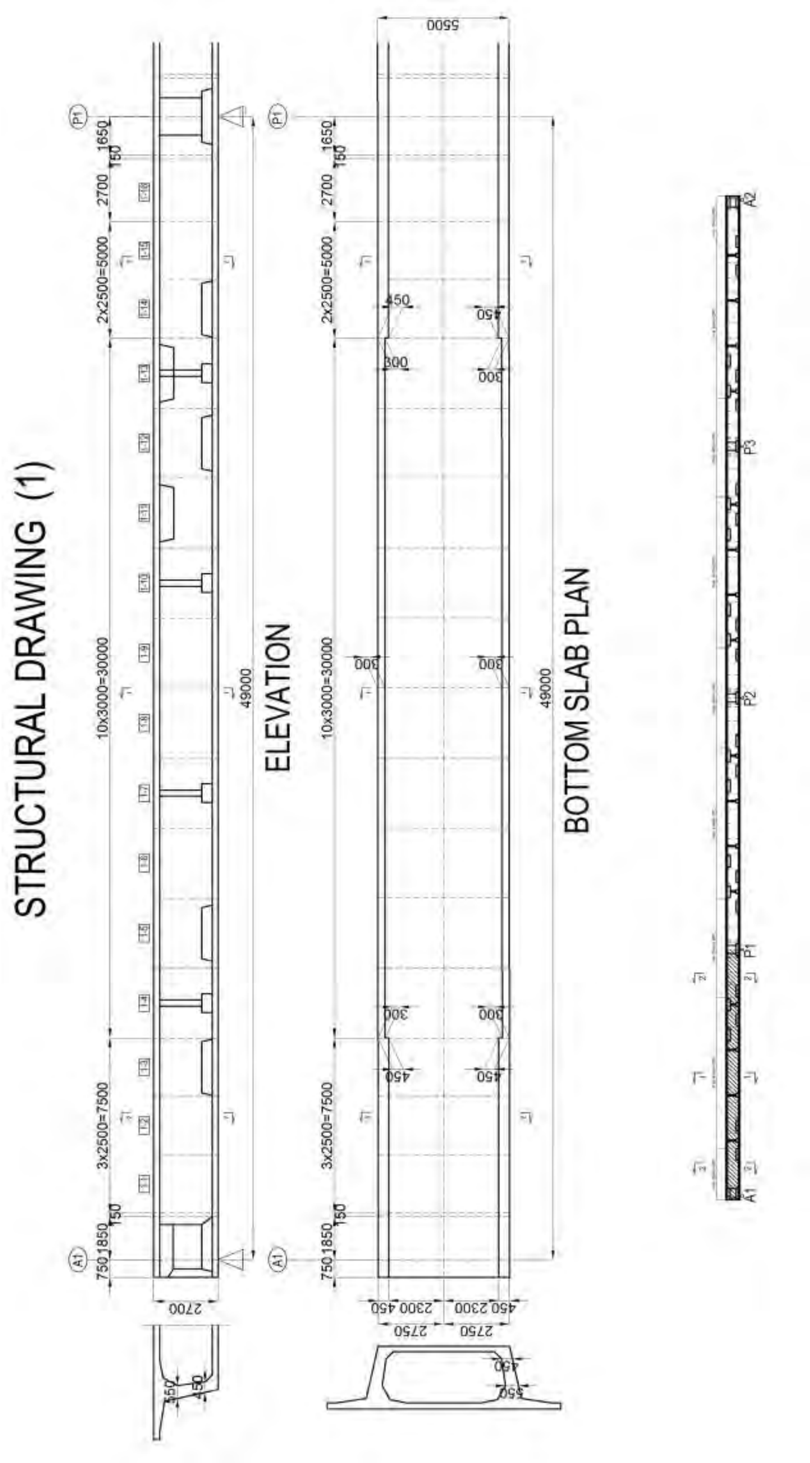
1 GENERAL

1-1 GENERAL CONDITION

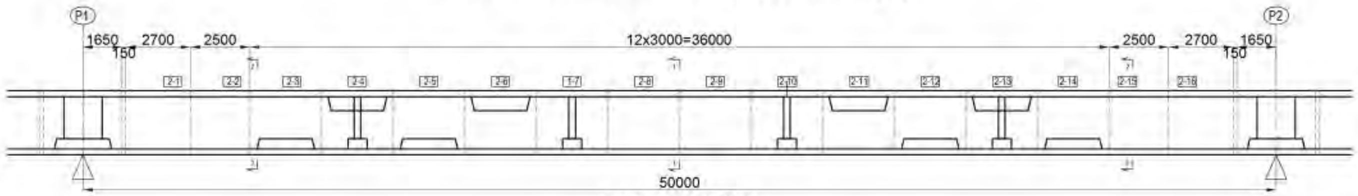
PROJECT	:	STUDY OF BRIDGE DESIGN
BRIDGE	:	PC BOX GIRDER BRIDGE (PROTOTYPE)
STURUCTURE TYPE	:	4 SPAN CONTINUOUS PC BOX GIRDER PRECAST SEGMENT
BRIDGE LENGTH	:	200 m (4 x 50m)
WIDTH COMPOSITION	:	0.600 + 1.500 + 2 x 3.500 + 0.500 + 0.600
LIVE LOAD	:	HL-93 (AASHTO)
DESIGN STANDARD	:	Specifications for highway bridges, (JRA) JAPAN AASHTO LRFD Bridge Design Specifications



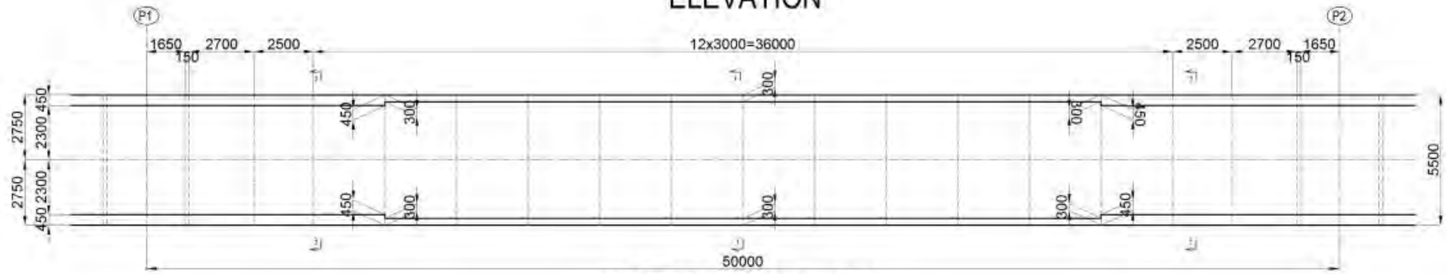
1-2 STRUCTURAL DRAWINGS



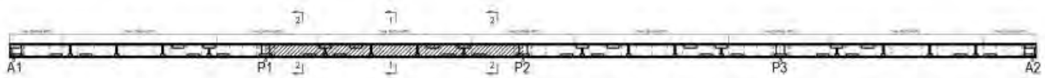
STRUCTURAL DRAWING (2)



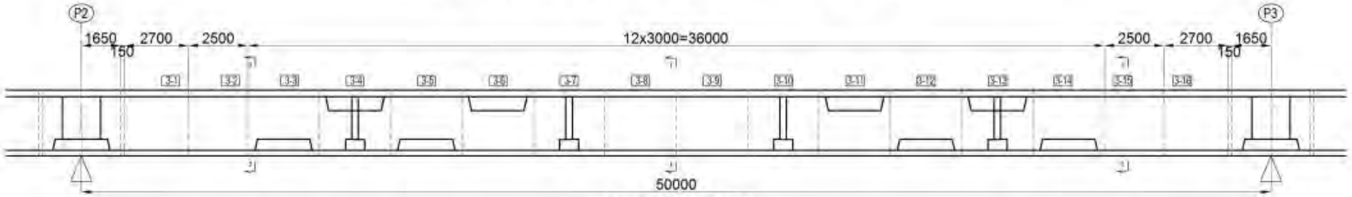
ELEVATION



BOTTOM SLAB PLAN



STRUCTURAL DRAWING (3)



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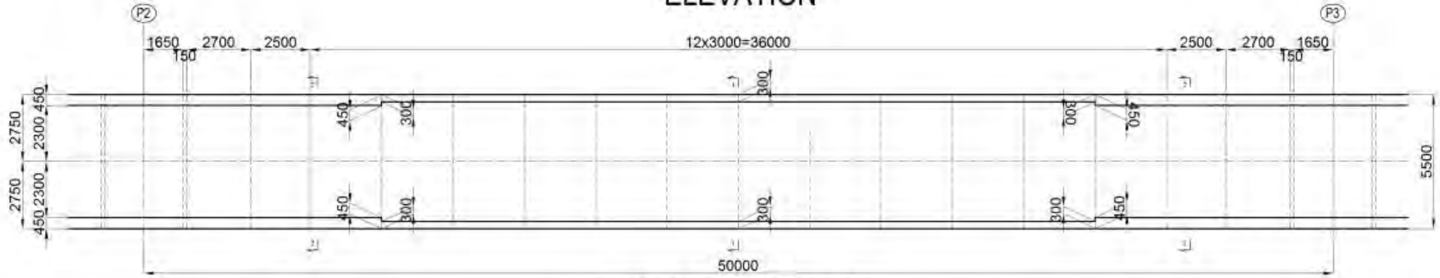

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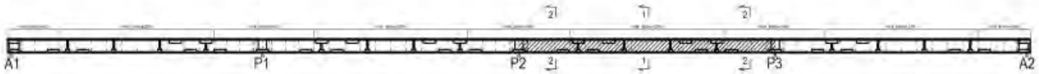
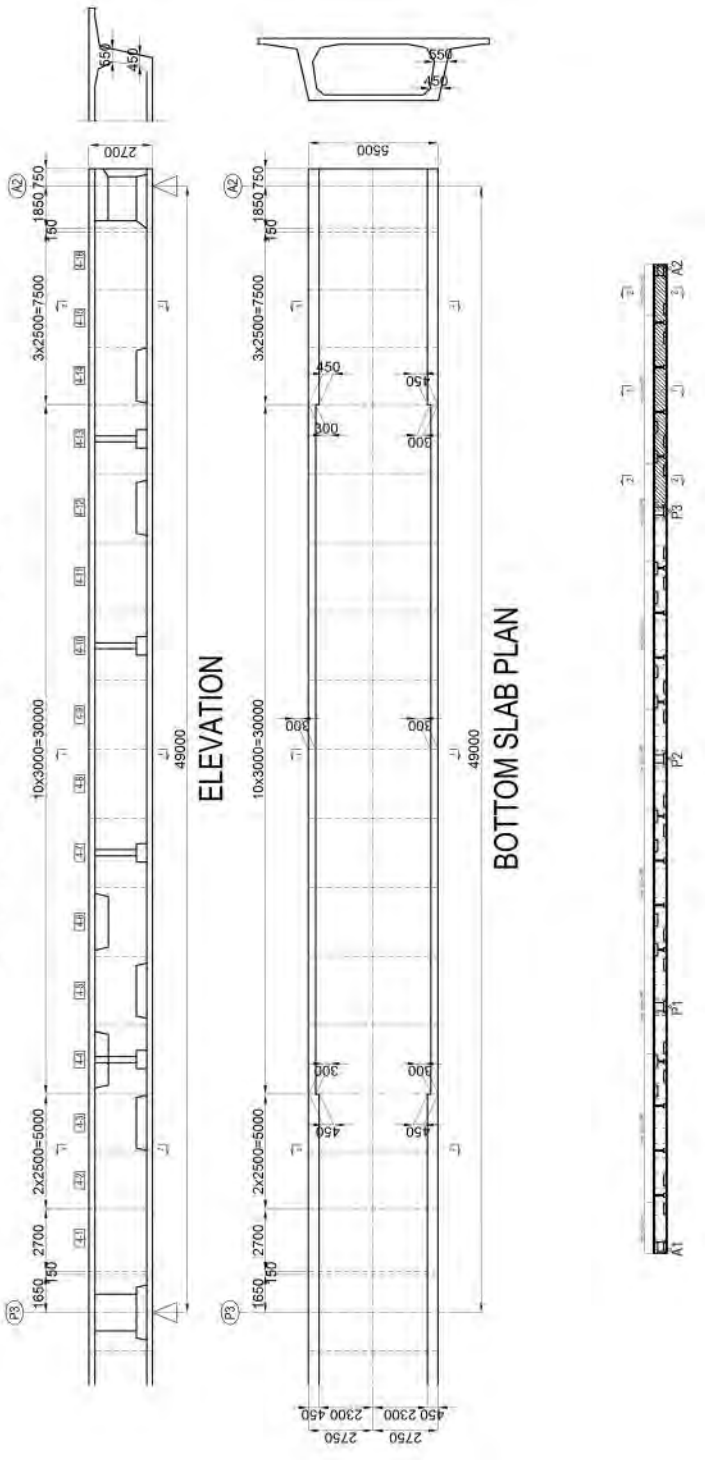
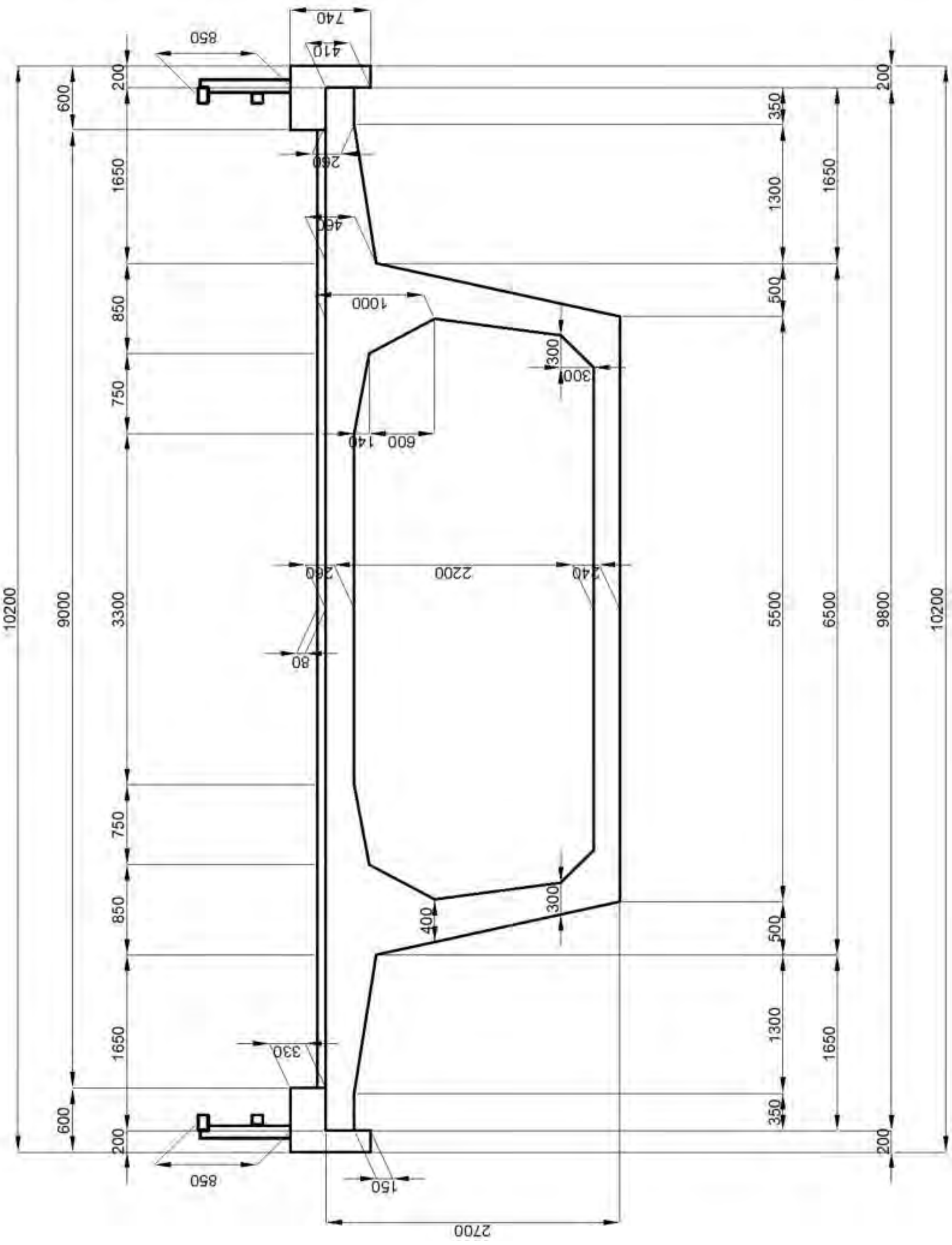


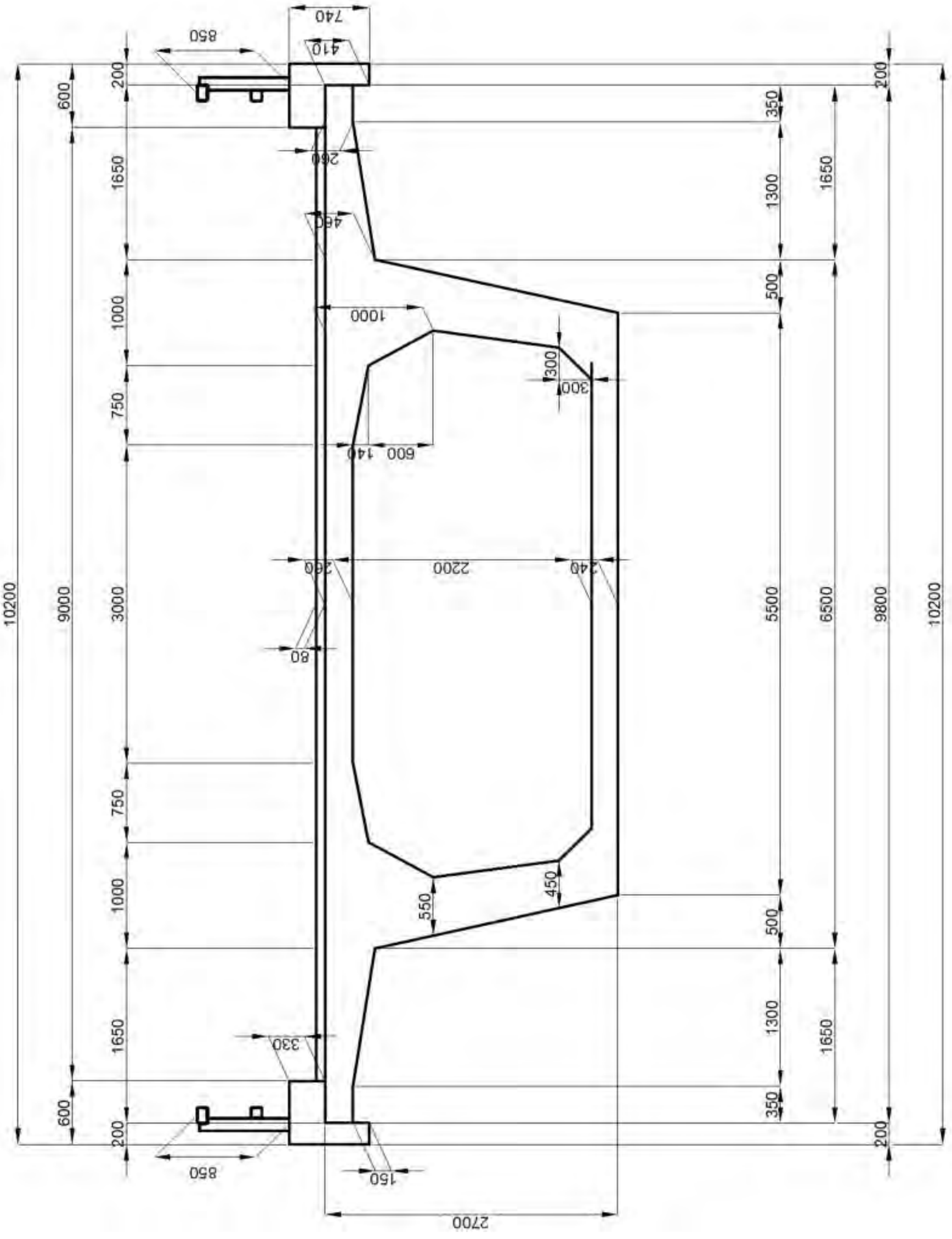
STRUCTURAL DRAWING (4)



CROSS SECTION @ 1-1

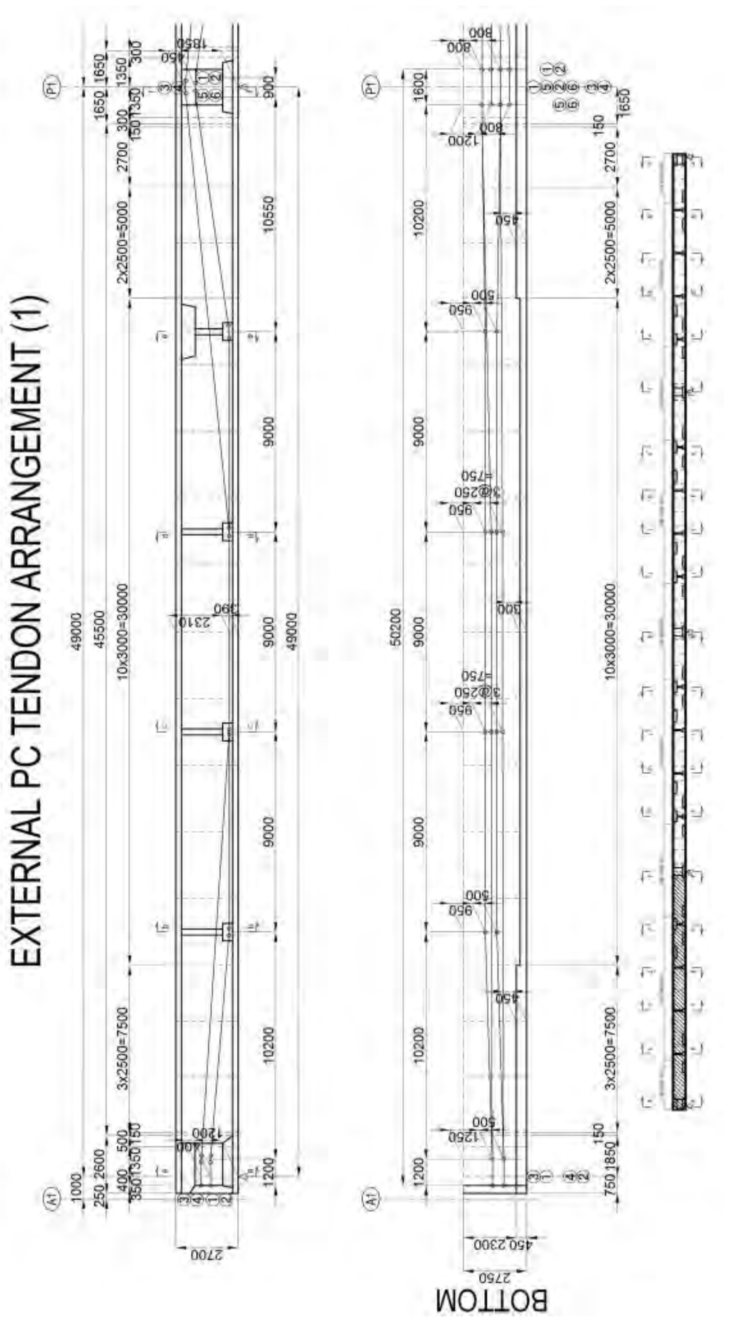


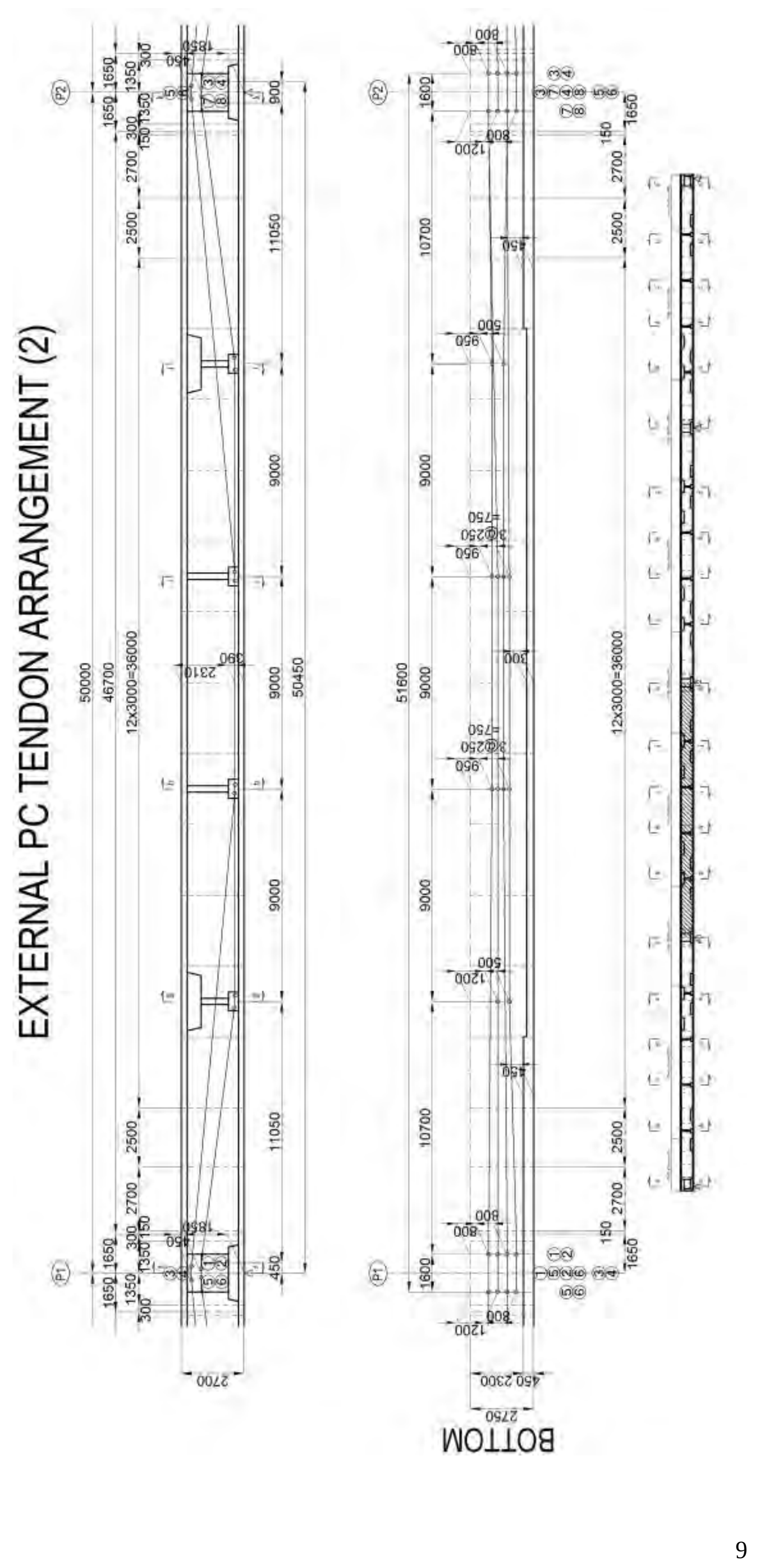
CROSS SECTION @ 2-2



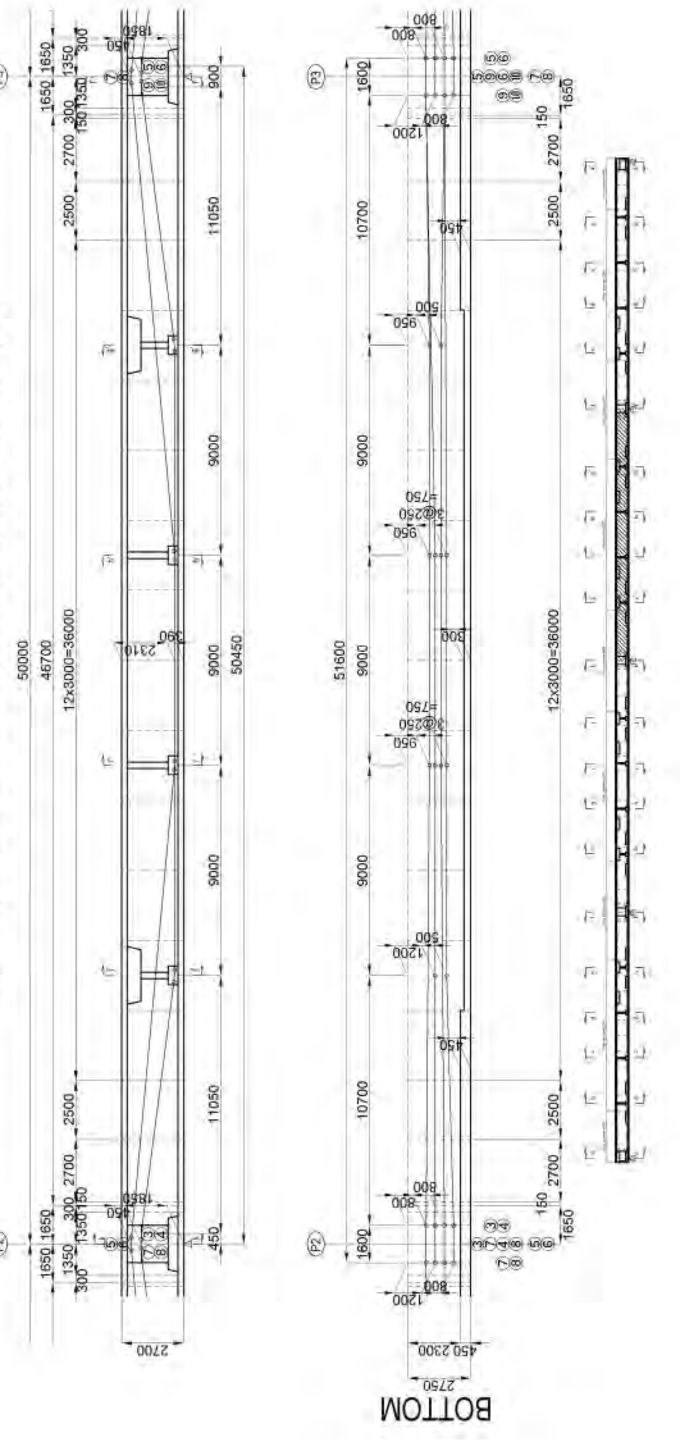
1-3 PC TENDON ARRANGEMENT

(1) External PC Tendon

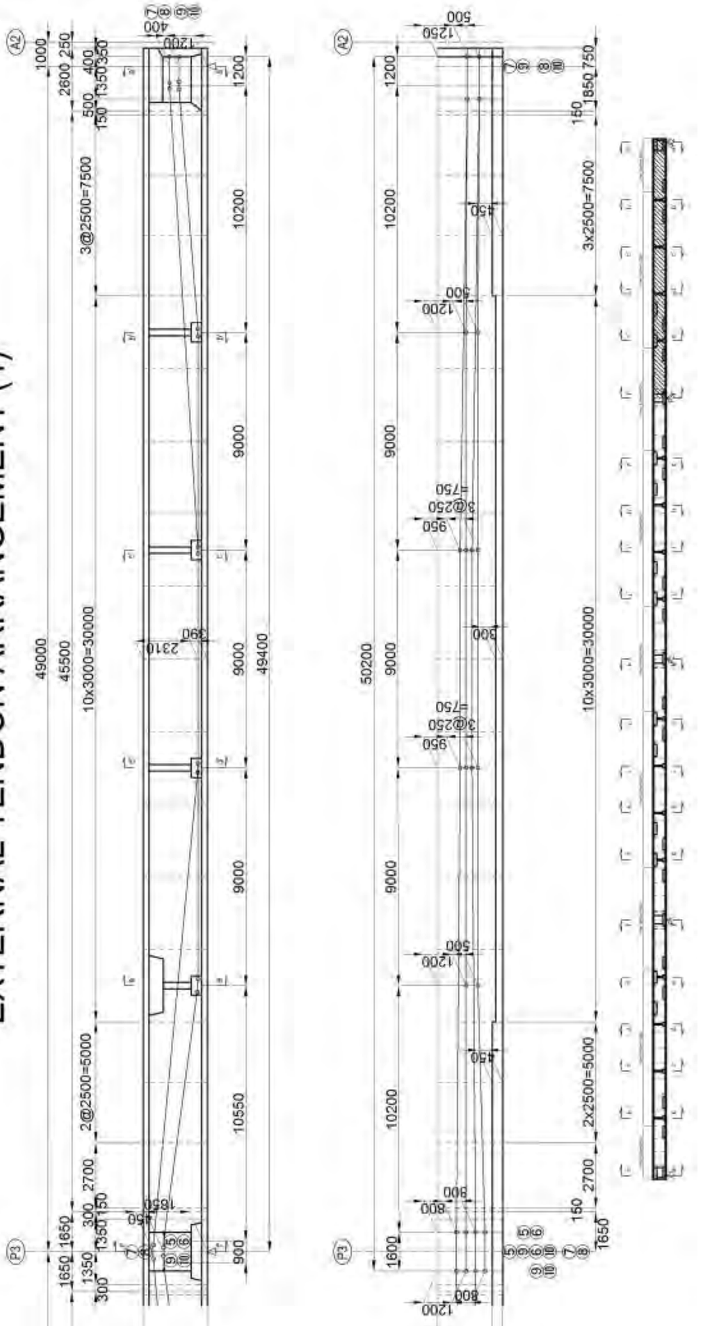



EXTERNAL PC TENDON ARRANGEMENT (2)
BOTTOM
P1
P2
50000
46700
12x3000=36000
50450
51600
11050
10700
9000
2700
2500
1650
1350
300
150
1600
2750
450 2300
3@250
=750
950
1200
800
500
450
2310
1850

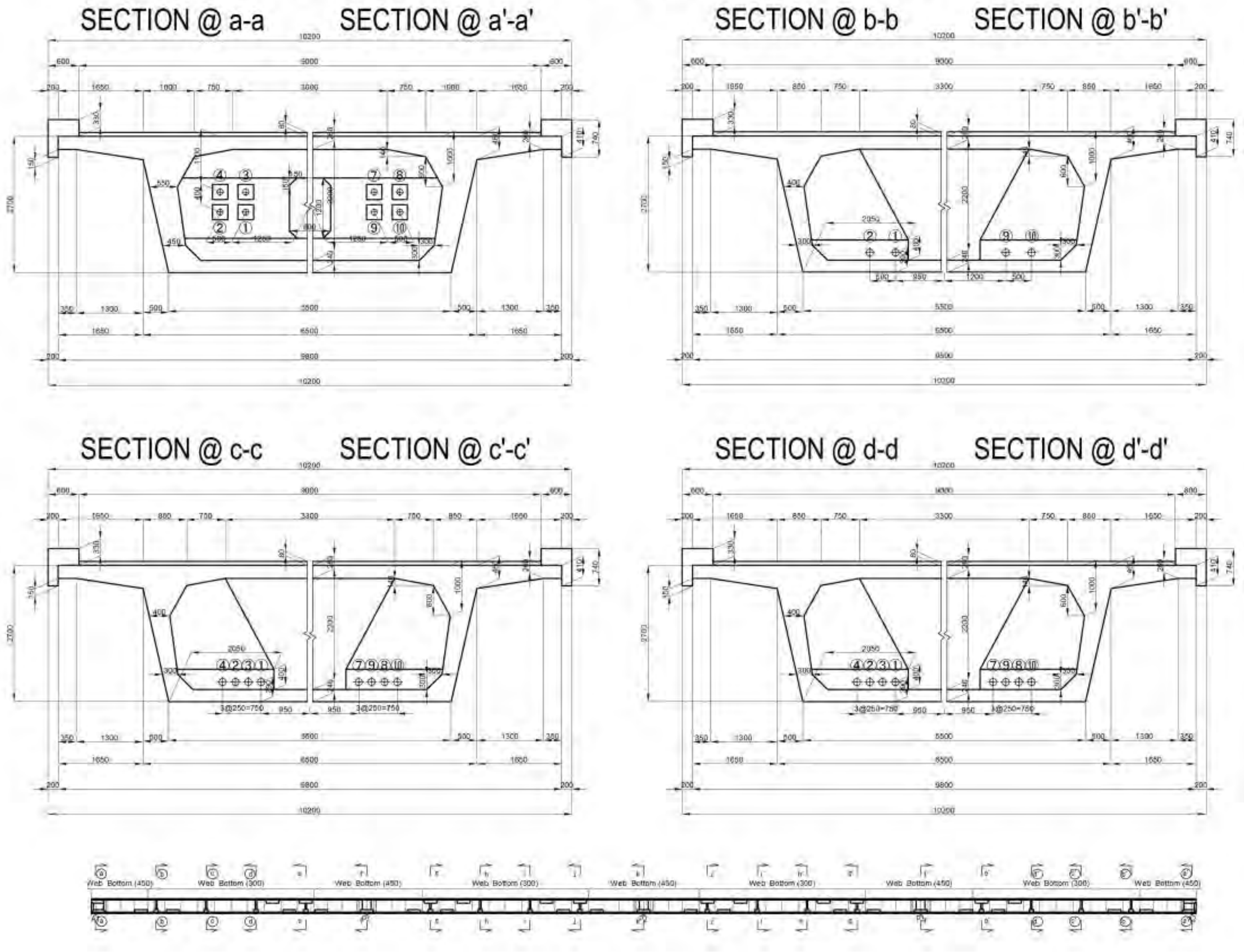
EXTERNAL PC TENDON ARRANGEMENT (3)



EXTERNAL TENDON ARRANGEMENT (4)



EXTERNAL TENDON PC ARRANGEMENT (1)



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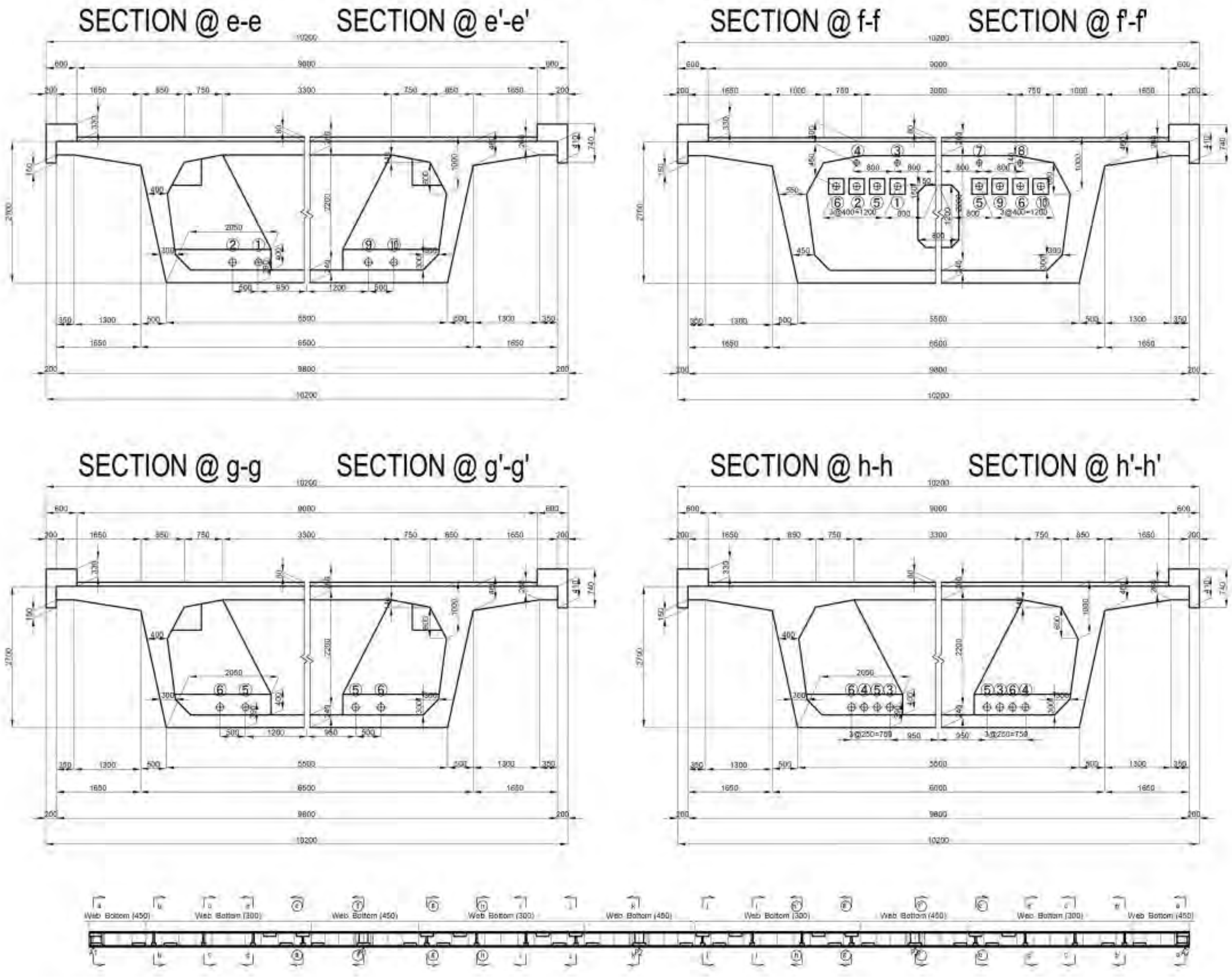
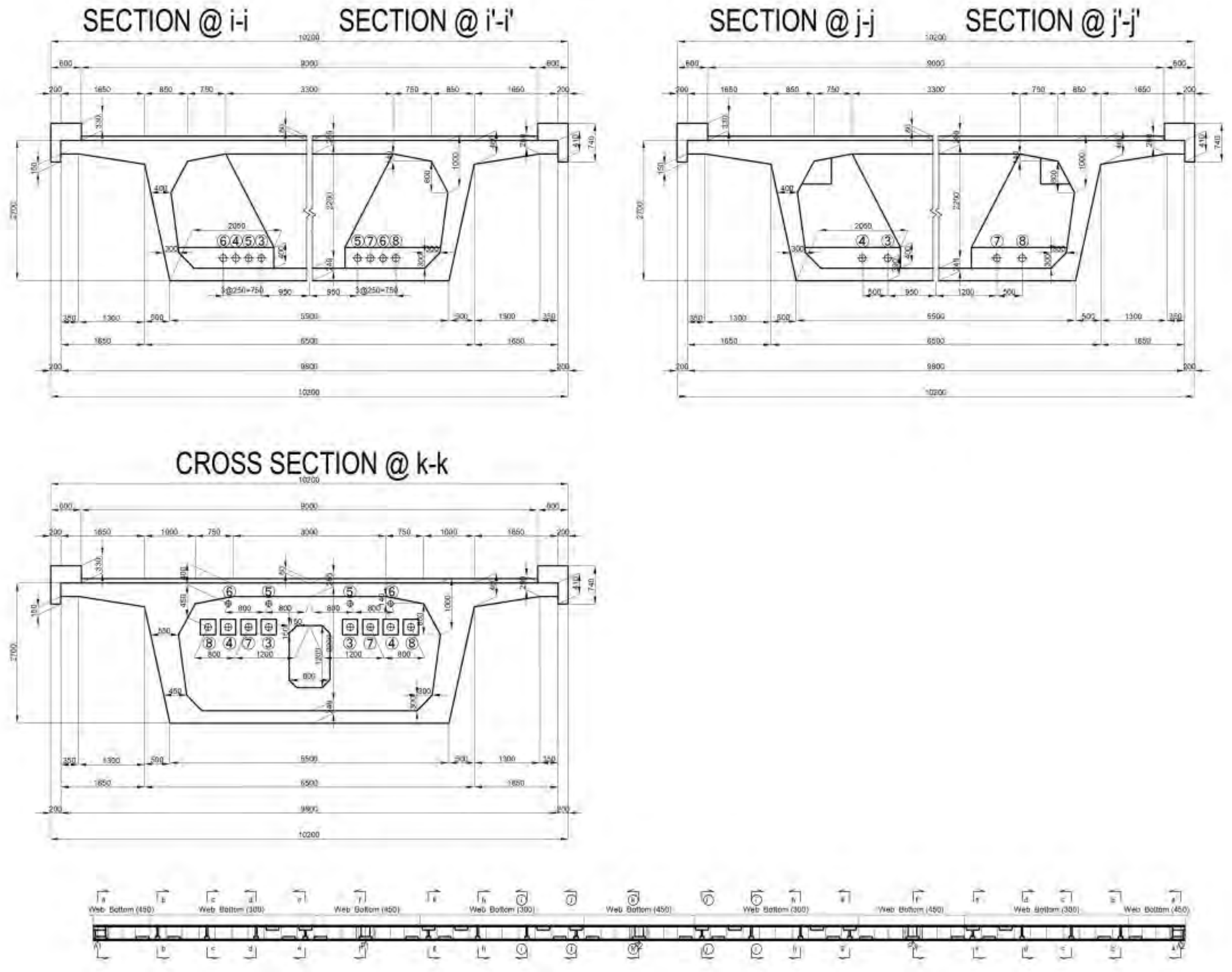
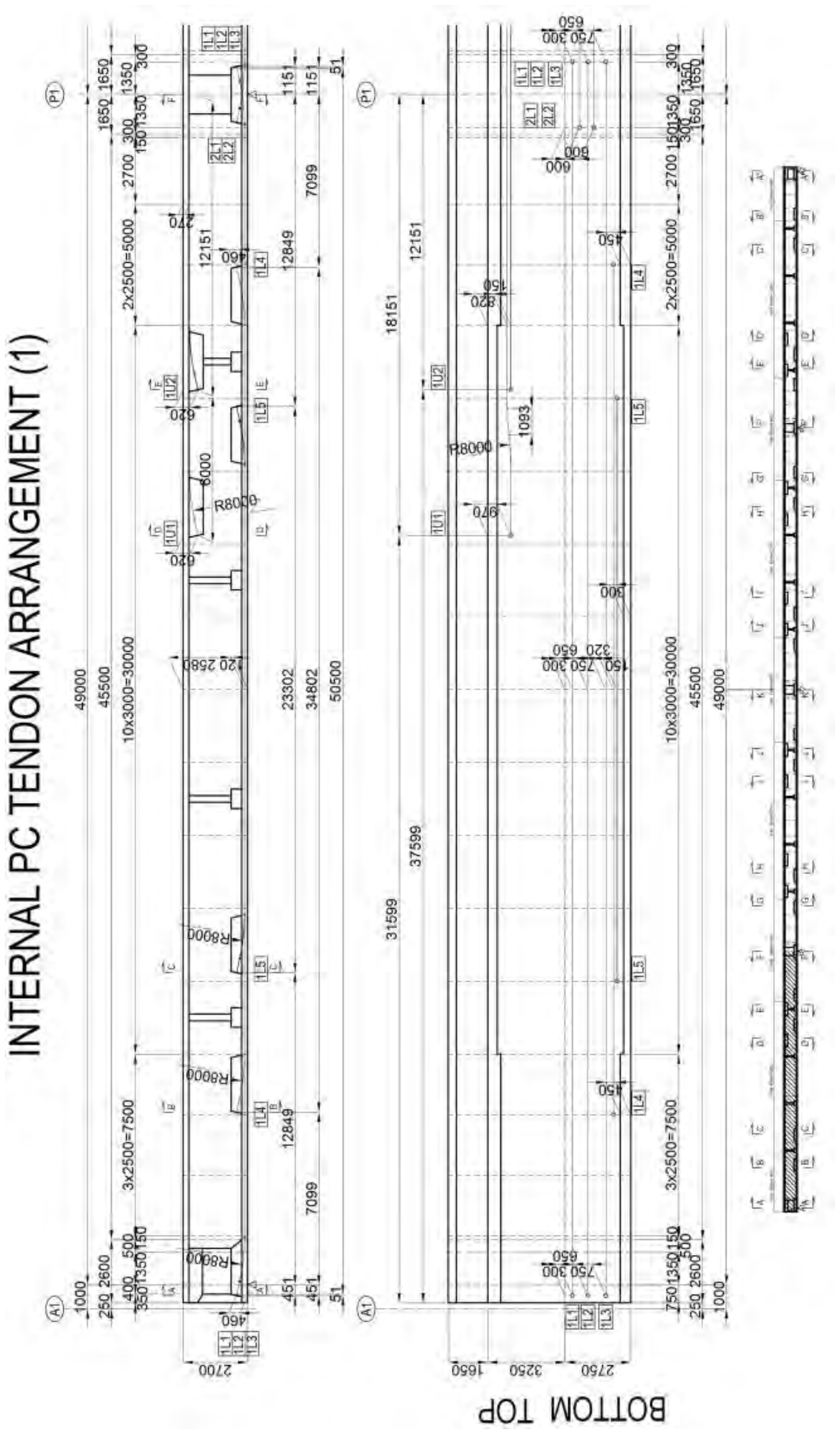


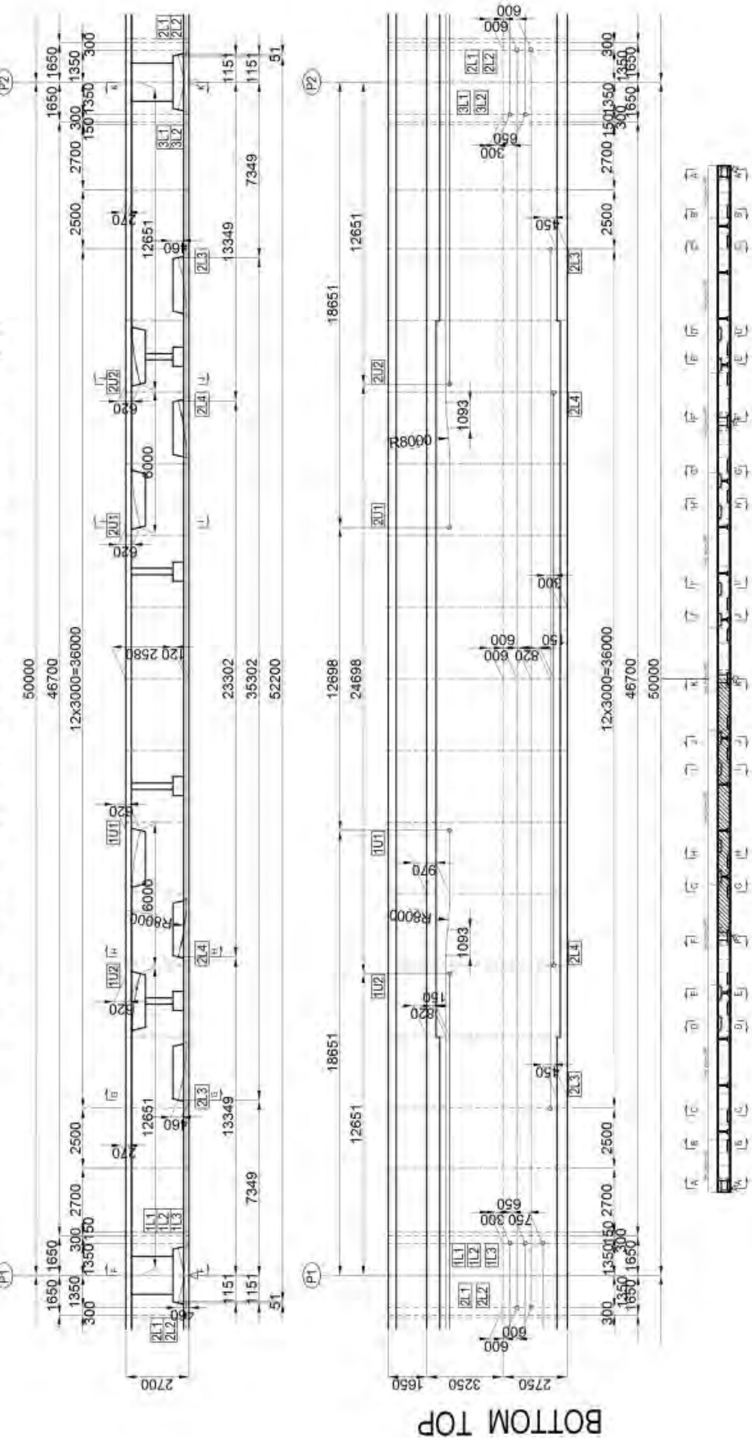
EXTERNAL PC TENDON ARRANGEMENT (3)



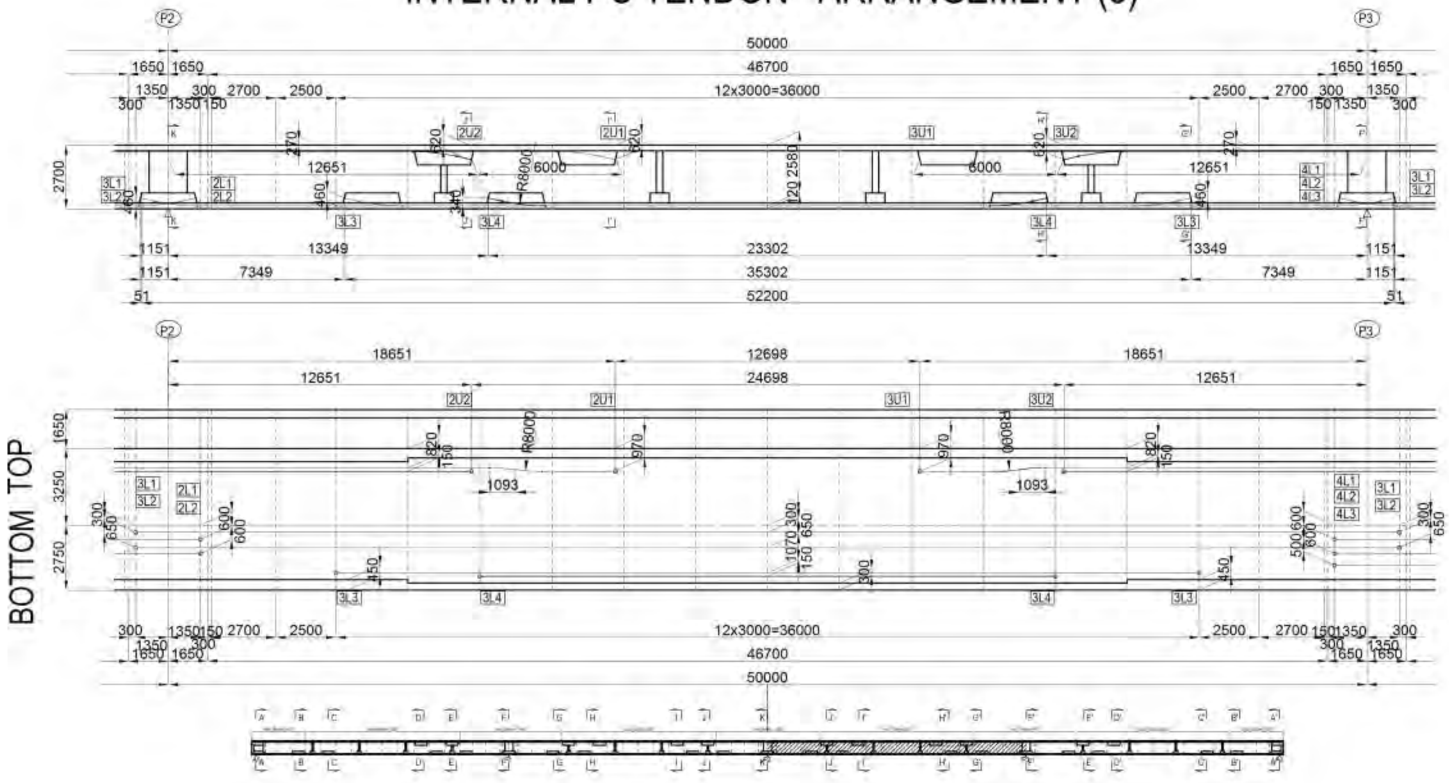
(2) Internal PC Tendon



INTERNAL PC TENDON ARRANGEMENT (2)



INTERNAL PC TENDON ARRANGEMENT (3)



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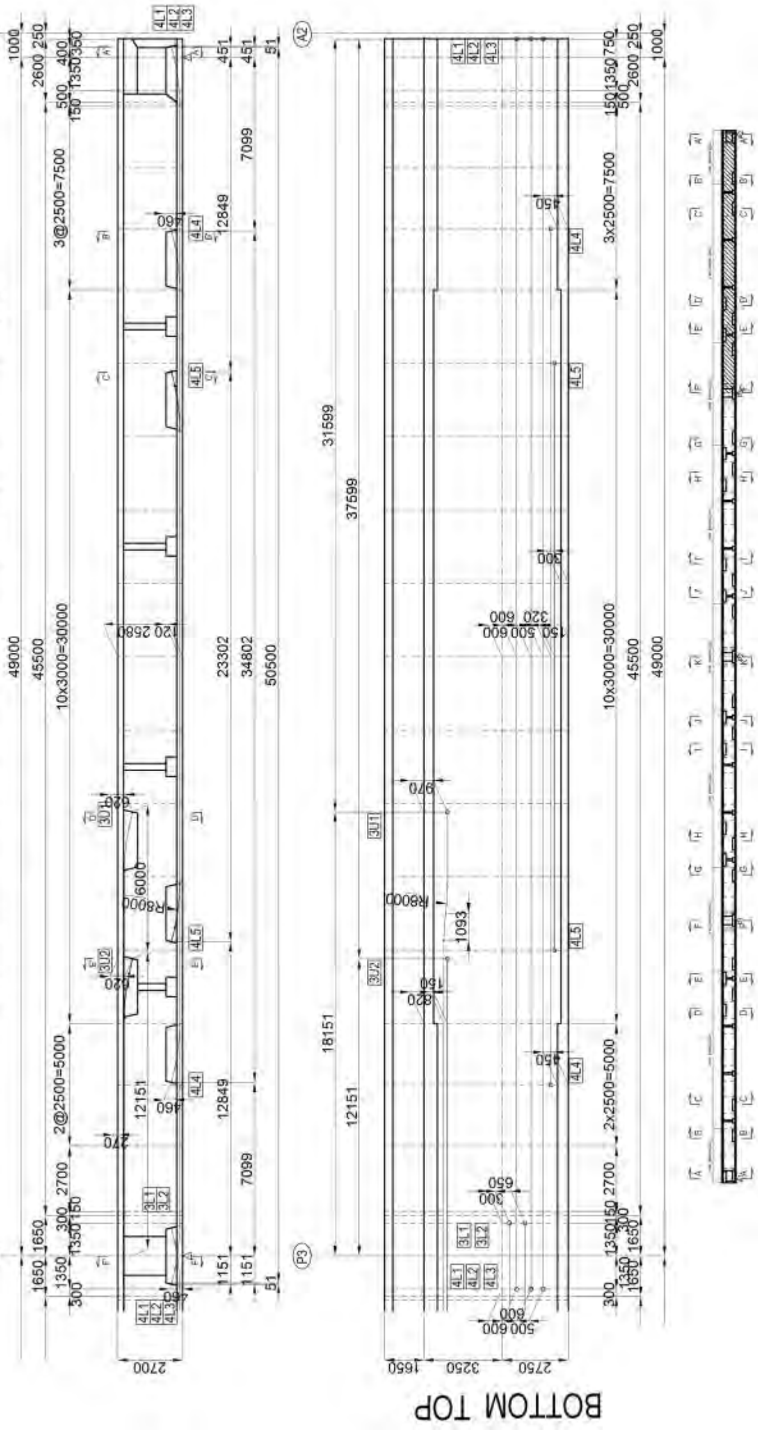
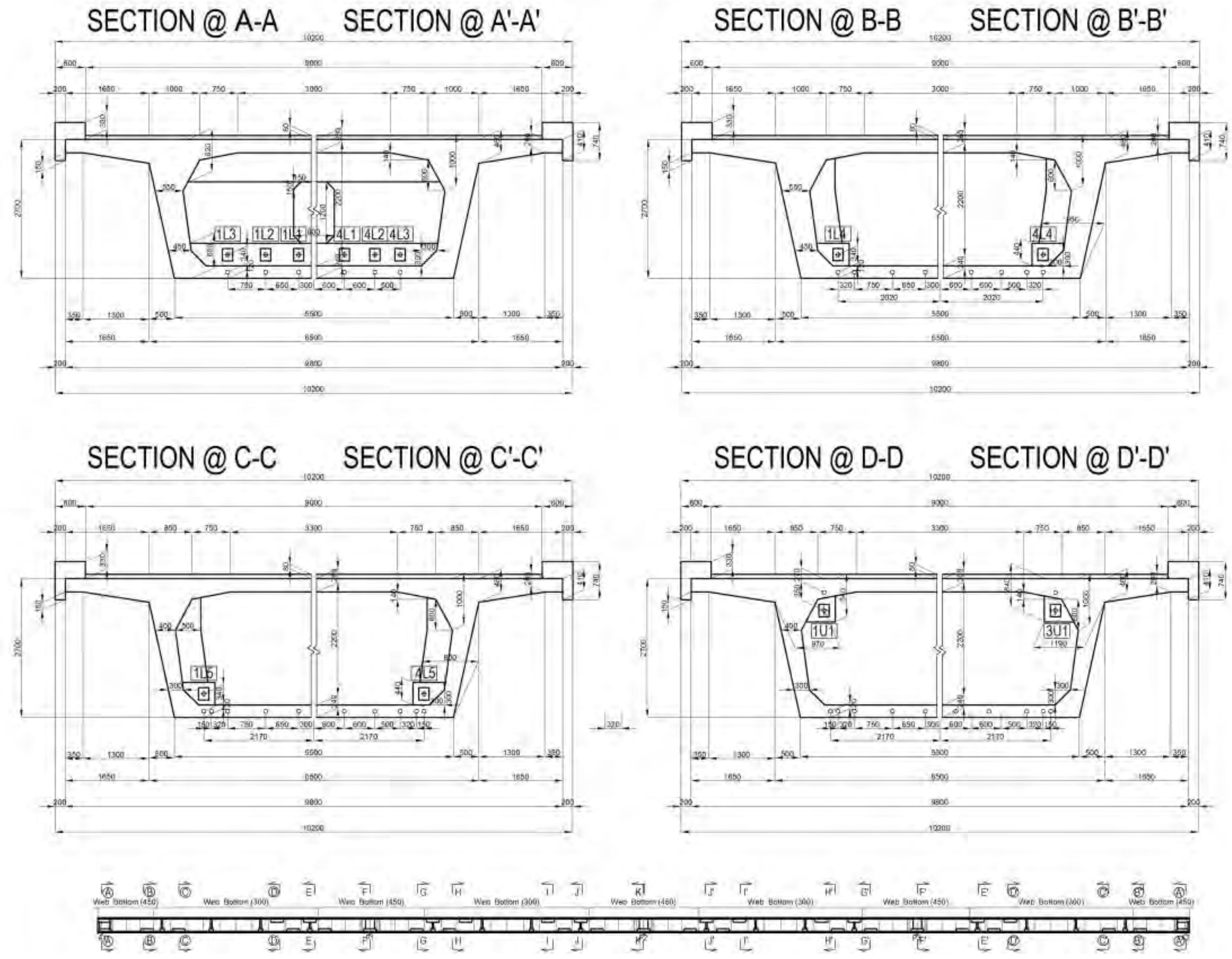
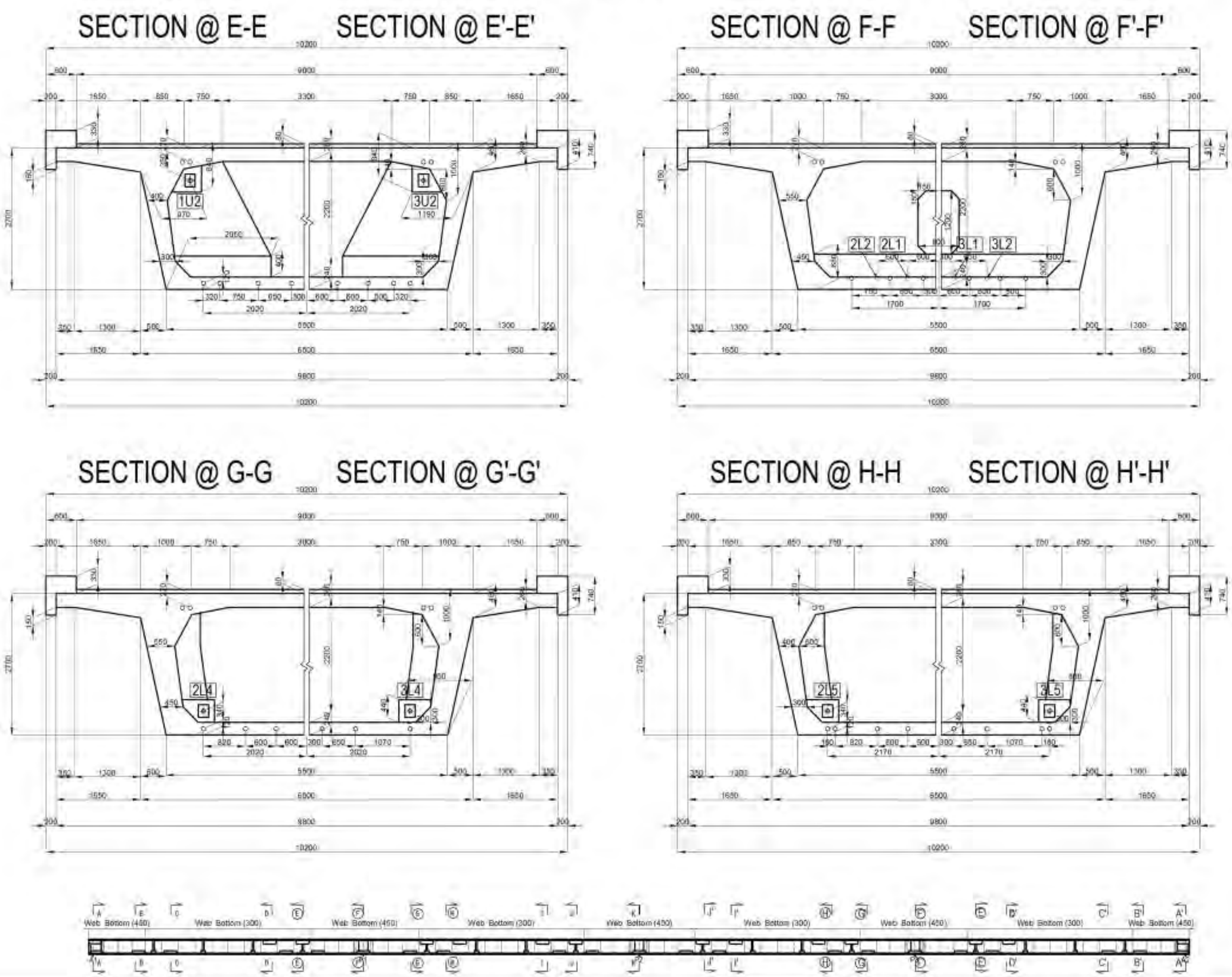


INTERNAL PC TENDON ARRANGEMENT (1)

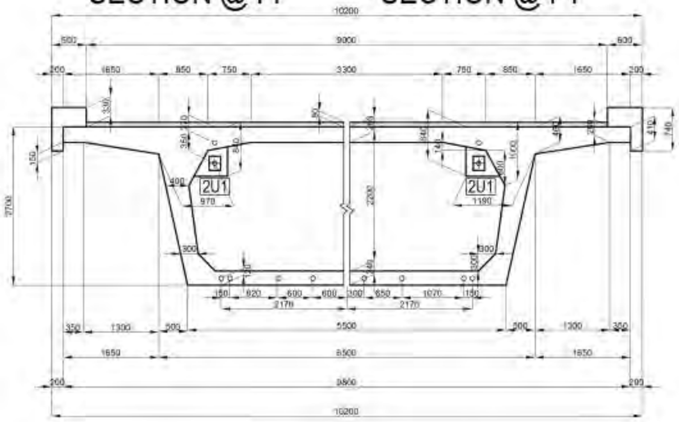


INTERNAL PC TENDON ARRANGEMENT (2)

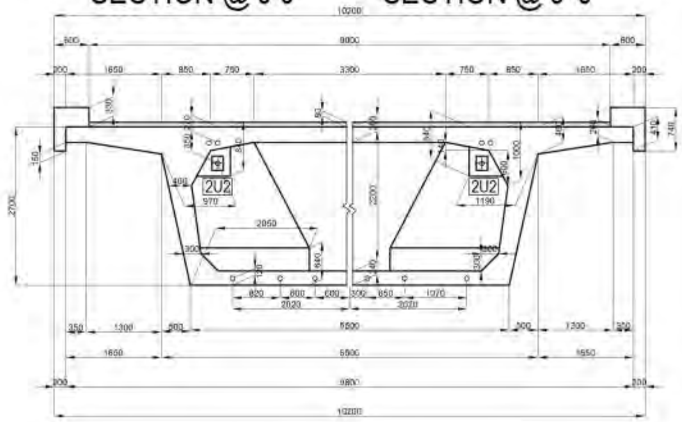


INTERNAL PC TENDON ARRANGEMENT (3)

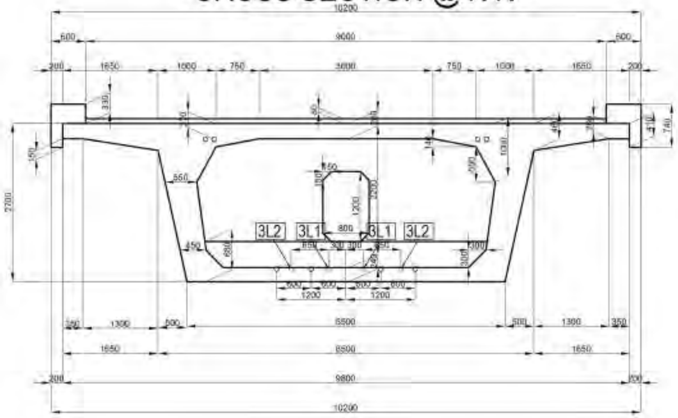
SECTION @ I-I SECTION @ I'-I'

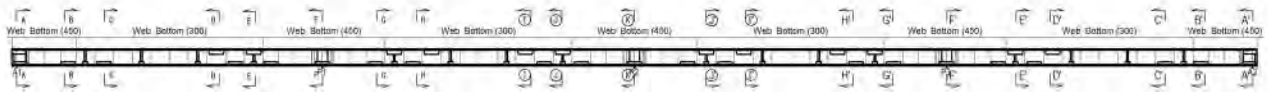


SECTION @ J-J SECTION @ J'-J'



CROSS SECTION @ K-K





1-3 PC TENDON ARRANGEMENT

(3) External PC Tendon Coordinates

EXTERNAL TENDON INPUT

Span-1

Elem	① x (m)	① y (m)	① z (m)	R (m)
1 to 24	0.600	1.250	1.200	0.0
	1.800	1.250	1.200	4.0
	12.000	0.950	0.390	4.0
	39.000	0.950	0.390	4.0
	49.550	0.800	1.850	4.0
	50.800	0.800	1.850	0.0

Elem	② x (m)	② y (m)	② z (m)	R (m)
1 to 24	0.600	1.750	1.200	0.0
	1.800	1.750	1.200	4.0
	12.000	1.450	0.390	4.0
	39.000	1.450	0.390	4.0
	49.550	1.600	1.850	4.0
	50.800	1.600	1.850	0.0

Span-2

Elem	③ x (m)	③ y (m)	③ z (m)	R (m)
1 to 46	0.600	1.250	1.600	0.0
	1.800	1.250	1.600	4.0
	21.000	1.200	0.390	4.0
	30.000	1.200	0.390	4.0
	50.000	0.800	2.300	3.0
	70.500	0.950	0.390	4.0
	88.500	0.950	0.390	4.0
	99.550	0.800	1.850	4.0
	100.800	0.800	1.850	0.0

Elem	④ x (m)	④ y (m)	④ z (m)	R (m)
1 to 46	0.600	1.750	1.600	0.0
	1.800	1.750	1.600	4.0
	21.000	1.700	0.390	4.0
	30.000	1.700	0.390	4.0
	50.000	1.600	2.300	3.0
	70.500	1.450	0.390	4.0
	88.500	1.450	0.390	4.0
	99.550	1.600	1.850	4.0
	100.800	1.600	1.850	0.0

Span-3

Elem	⑤ x (m)	⑤ y (m)	⑤ z (m)	R (m)
23 to 68	49.200	1.200	1.850	0.0
	50.450	1.200	1.850	4.0
	61.500	1.200	0.390	4.0
	79.500	1.200	0.390	4.0
	100.000	0.800	2.300	3.0
	120.500	0.950	0.390	4.0
	138.500	0.950	0.390	4.0
	149.550	0.800	1.850	4.0
	150.800	0.800	1.850	0.0

Elem	⑥ x (m)	⑥ y (m)	⑥ z (m)	R (m)
23 to 68	49.200	2.000	1.850	0.0
	50.450	2.000	1.850	4.0
	61.500	1.700	0.390	4.0
	79.500	1.700	0.390	4.0
	100.000	1.600	2.300	3.0
	120.500	1.450	0.390	4.0
	138.500	1.450	0.390	4.0
	149.550	1.600	1.850	4.0
	150.800	1.600	1.850	0.0

Note :
1. Similarly consider for Left side of Girder in y-coordinate (negative dir) respectively.

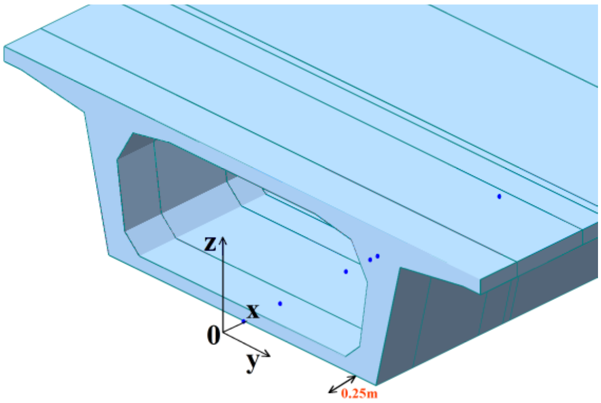
Span-4

Elem	⑦ x (m)	⑦ y (m)	⑦ z (m)	R (m)
45 to 90	99.200	1.200	1.850	0.0
	100.450	1.200	1.850	4.0
	111.500	1.200	0.390	4.0
	129.500	1.200	0.390	4.0
	150.000	0.800	2.300	3.0
	170.000	0.950	0.390	4.0
	179.000	0.950	0.390	4.0
	198.200	0.800	1.600	4.0
	199.400	0.800	1.600	0.0

Elem	⑧ x (m)	⑧ y (m)	⑧ z (m)	R (m)
45 to 90	99.200	2.000	1.850	0.0
	100.450	2.000	1.850	4.0
	111.500	1.700	0.390	4.0
	129.500	1.700	0.390	4.0
	150.000	1.600	2.300	3.0
	170.000	1.450	0.390	4.0
	179.000	1.450	0.390	4.0
	198.200	1.600	1.600	4.0
	199.400	1.600	1.600	0.0

Elem	⑨ x (m)	⑨ y (m)	⑨ z (m)	R (m)
68 to 90	149.200	1.200	1.850	0.0
	150.450	1.200	1.850	4.0
	161.000	1.200	0.390	4.0
	188.000	1.200	0.390	4.0
	198.200	1.250	1.200	4.0
	199.400	1.250	1.200	0.0

Elem	⑩ x (m)	⑩ y (m)	⑩ z (m)	R (m)
68 to 90	149.200	2.000	1.850	0.0
	150.450	2.000	1.850	4.0
	161.000	1.700	0.390	4.0
	188.000	1.700	0.390	4.0
	198.200	1.750	1.200	4.0
	199.400	1.750	1.200	0.0



(4) Internal PC Tendon Coordinates

INTERNAL TENDON INPUT

Span-1

1L1

Elem	x (m)	y (m)	z (m)	R (m)
1 to 24	0.549	0.300	0.460	0.0
	2.022	0.300	0.120	8.0
	49.678	0.300	0.120	8.0
	51.151	0.300	0.460	0.0

1L2

Elem	x (m)	y (m)	z (m)	R (m)
1 to 24	0.549	0.950	0.460	0.0
	2.022	0.950	0.120	8.0
	49.678	0.950	0.120	8.0
	51.151	0.950	0.460	0.0

1L3

Elem	x (m)	y (m)	z (m)	R (m)
1 to 24	0.549	1.700	0.460	0.0
	2.022	1.700	0.120	8.0
	49.678	1.700	0.120	8.0
	51.151	1.700	0.460	0.0

1L4

Elem	x (m)	y (m)	z (m)	R (m)
7 to 18	8.100	2.020	0.460	0.0
	9.572	2.020	0.120	8.0
	41.428	2.020	0.120	8.0
	42.900	2.020	0.460	0.0

1L5

Elem	x (m)	y (m)	z (m)	R (m)
9 to 16	13.854	2.170	0.460	0.0
	15.327	2.170	0.120	8.0
	35.673	2.170	0.120	8.0
	37.146	2.170	0.460	0.0

Span-2

1U1

Elem	x (m)	y (m)	z (m)	R (m)
15 to 33	31.849	2.280	2.080	0.0
	33.365	2.280	2.430	8.0
	34.907	2.280	2.430	8.0
	36.000	2.430	2.430	8.0
	64.500	2.430	2.430	8.0
	65.593	2.280	2.430	8.0
	67.135	2.280	2.430	8.0
	68.651	2.280	2.080	0.0

1U2

Elem	x (m)	y (m)	z (m)	R (m)
17 to 30	37.849	2.280	2.080	0.0
	39.365	2.280	2.430	8.0
	61.135	2.280	2.430	8.0
	62.651	2.280	2.080	0.0

2L1

Elem	x (m)	y (m)	z (m)	R (m)
23 to 46	48.849	0.600	0.460	0.0
	50.322	0.600	0.120	8.0
	99.678	0.600	0.120	8.0
	101.151	0.600	0.460	0.0

2L2

Elem	x (m)	y (m)	z (m)	R (m)
23 to 46	48.849	1.200	0.460	0.0
	50.322	1.200	0.120	8.0
	99.678	1.200	0.120	8.0
	101.151	1.200	0.460	0.0

2L3

Elem	x (m)	y (m)	z (m)	R (m)
29 to 40	57.349	2.020	0.460	0.0
	58.822	2.020	0.120	8.0
	91.178	2.020	0.120	8.0
	92.651	2.020	0.460	0.0

2L4

Elem	x (m)	y (m)	z (m)	R (m)
31 to 38	63.349	2.170	0.460	0.0
	64.822	2.170	0.120	8.0
	85.178	2.170	0.120	8.0
	86.651	2.170	0.460	0.0

Span-3

2U1

Elem	x (m)	y (m)	z (m)	R (m)
37 to 54	81.349	2.280	2.080	0.0
	82.865	2.280	2.430	8.0
	84.407	2.280	2.430	8.0
	85.500	2.430	2.430	8.0
	114.500	2.430	2.430	8.0
	115.593	2.280	2.430	8.0
	117.135	2.280	2.430	8.0
	118.651	2.280	2.080	0.0

2U2

Elem	x (m)	y (m)	z (m)	R (m)
39 to 52	87.349	2.280	2.080	0.0
	88.865	2.280	2.430	8.0
	111.135	2.280	2.430	8.0
	112.651	2.280	2.080	0.0

Note :
1. Similarly consider for Left side of Girder in y-coordinate (negative dir) respectively.

3L1

Elem	x (m)	y (m)	z (m)	R (m)
45 to 68	98.849	0.300	0.460	0.0
	100.322	0.300	0.120	8.0
	149.678	0.300	0.120	8.0
	151.151	0.300	0.460	0.0

3L2

Elem	x (m)	y (m)	z (m)	R (m)
45 to 68	98.849	0.950	0.460	0.0
	100.322	0.950	0.120	8.0
	149.678	0.950	0.120	8.0
	151.151	0.950	0.460	0.0

3L3

Elem	x (m)	y (m)	z (m)	R (m)
51 to 62	107.349	2.020	0.460	0.0
	108.822	2.020	0.120	8.0
	141.178	2.020	0.120	8.0
	142.651	2.020	0.460	0.0

3L4

Elem	x (m)	y (m)	z (m)	R (m)
53 to 60	113.349	2.017	0.460	0.0
	114.822	2.017	0.120	8.0
	135.178	2.017	0.120	8.0
	136.651	2.017	0.460	0.0

Span-4

3U1

Elem	x (m)	y (m)	z (m)	R (m)
59 to 76	131.349	2.280	2.080	0.0
	132.865	2.280	2.430	8.0
	134.407	2.280	2.430	8.0
	135.500	2.430	2.430	8.0
	164.000	2.430	2.430	8.0
	165.093	2.280	2.430	8.0
	166.635	2.280	2.430	8.0
	168.151	2.280	2.080	0.0

3U2

Elem	x (m)	y (m)	z (m)	R (m)
61 to 74	137.349	2.280	2.080	0.0
	138.865	2.280	2.430	8.0
	160.635	2.280	2.430	8.0
	162.151	2.280	2.080	0.0

4L5

Elem	x (m)	y (m)	z (m)	R (m)
75 to 82	162.854	2.170	0.460	0.0
	164.327	2.170	0.120	8.0
	184.673	2.170	0.120	8.0
	186.146	2.170	0.460	0.0

4L1

Elem	x (m)	y (m)	z (m)	R (m)
67 to 90	148.849	0.600	0.460	0.0
	150.322	0.600	0.120	8.0
	197.978	0.600	0.120	8.0
	199.451	0.600	0.460	0.0

4L2

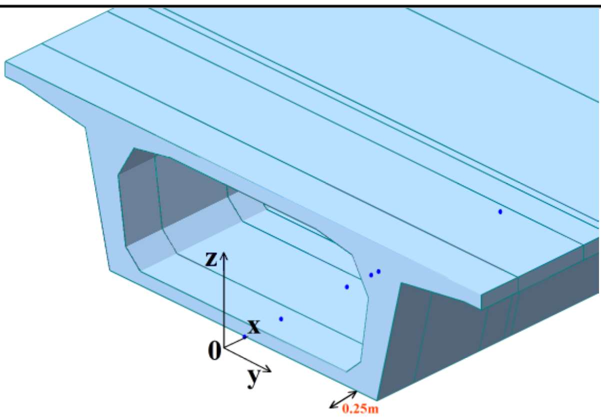
Elem	x (m)	y (m)	z (m)	R (m)
67 to 90	148.849	1.200	0.460	0.0
	150.322	1.200	0.120	8.0
	197.978	1.200	0.120	8.0
	199.451	1.200	0.460	0.0

4L3

Elem	x (m)	y (m)	z (m)	R (m)
67 to 90	148.849	1.700	0.460	0.0
	150.322	1.700	0.120	8.0
	197.978	1.700	0.120	8.0
	199.451	1.700	0.460	0.0

4L4

Elem	x (m)	y (m)	z (m)	R (m)
73 to 84	157.100	2.020	0.460	0.0
	158.572	2.020	0.120	8.0
	190.428	2.020	0.120	8.0
	191.900	2.020	0.460	0.0



1-4 CONSTRUCTION STAGES

Each construction stage Cycle duration is 14 days period.

Construction Stage-1

150 days

Construction Stage-2

164 days

Construction Stage-3

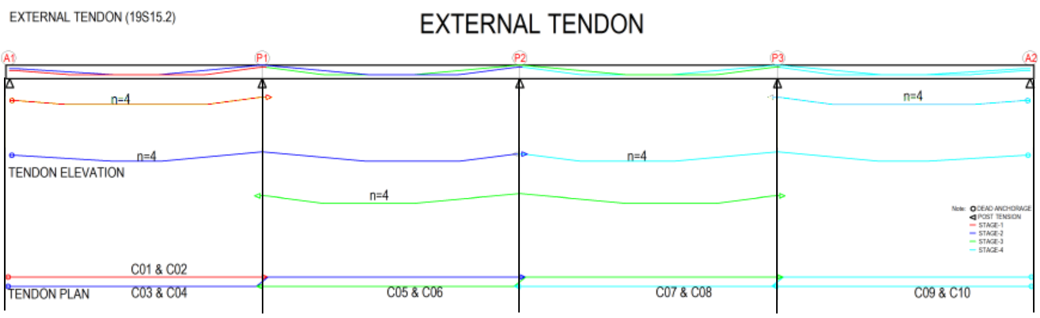
178 days

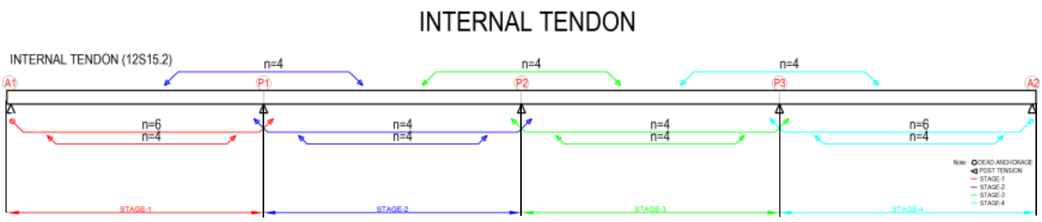
Construction Stage-4

192 days

Construction Stage-5 Super Imposed Load 300 days

Construction Stage-6 Design Check 20000 days



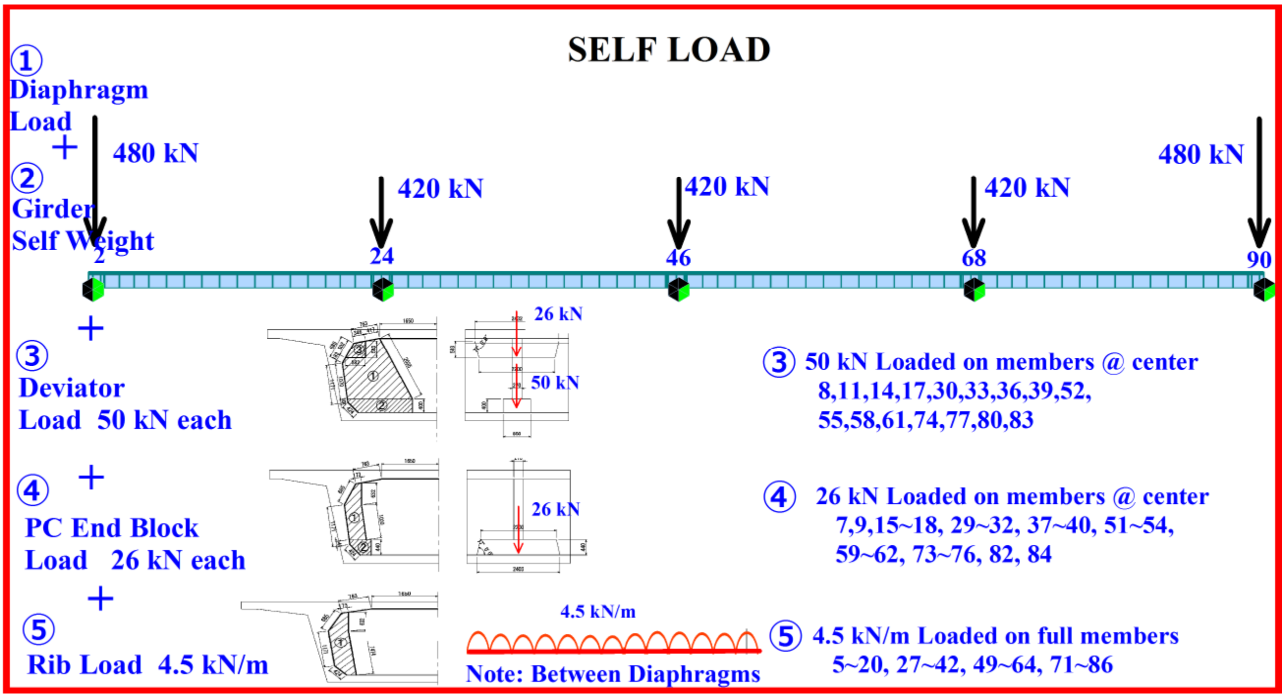


2 DESIGN CONDITIONS

2-1 LOAD CONDITION

(1) SELF WEIGHT

REINFORCED CONCRETE	:	24.5 kN/m^3
PRESTRESSED CONCRETE	:	24.5 kN/m^3
PLAIN CONCRETE	:	23.0 kN/m^3
ASPHALT CONCRETE	:	22.5 kN/m^3
STEEL	:	77.0 kN/m^3



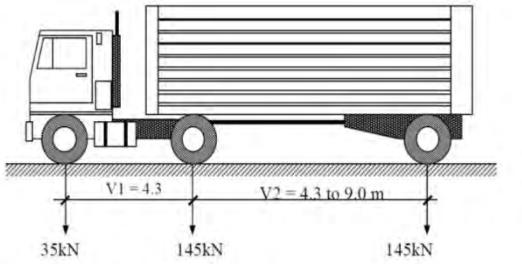
(2) SUPER IMPOSED LOAD

PAVEMENT (t = 80mm)	:	1.8 kN/m^2
OVERLAY	:	0.7 kN/m^2
CURB	:	24.5 kN/m^3
RAILINGS (each side)	:	0.7 kN/m
WATER LINE	:	3.00 kN/m

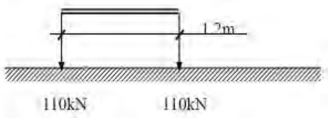
(3) LIVE LOAD

LIVE LOAD is according to AASHTO LRFD Bridge Design Specifications.
IMPACT is according to Specifications for highway bridges, JAPAN.

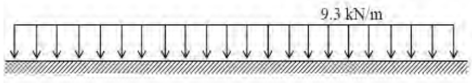
TRUCK



TANDEM



LANE



Design lane width = 3.0 m
Number of design lane = 9.0 m / 3.0 m = 3 Lanes

Table 3.6.1.1.2-1—Multiple Presence Factors, *m*

Number of Loaded Lanes	Multiple Presence Factors, *m*
1	1.20
2	1.00
3	0.85
>3	0.65

(4) CREEP AND SHRINKAGE

According to CEB-FIB-2010 & JRA

Relative humidity : **74.6 %**

Equivalent thickness or Nomial size of member : h (h=2*A/u) , **h = 0.43 m**

Type of Cement : **Normal (32.5 R, 425 N)**

28 days Charcteristic Cylindrical strength of Concrete (time dependent material) : **50.0 N/mm^2**

Age of Concrete beginning : **3days**

Type of Aggregate : **Quartzite**

2-2 MATERIALS

(1) CONCRETE

Specified compressive strength	:	50.0 N/mm^2
Young's modulus	:	3.30E+04 N/mm^2
Shear modulus	:	1.43E+04 N/mm^2
Coefficient of thermal expansion	:	1.00E-05 / ℃

(2) REINFORCEMENT

Reinforcement type	:	SD345
Yeild strength	:	345.0 N/mm^2
Young's modulus	:	2.00E+05 N/mm^2

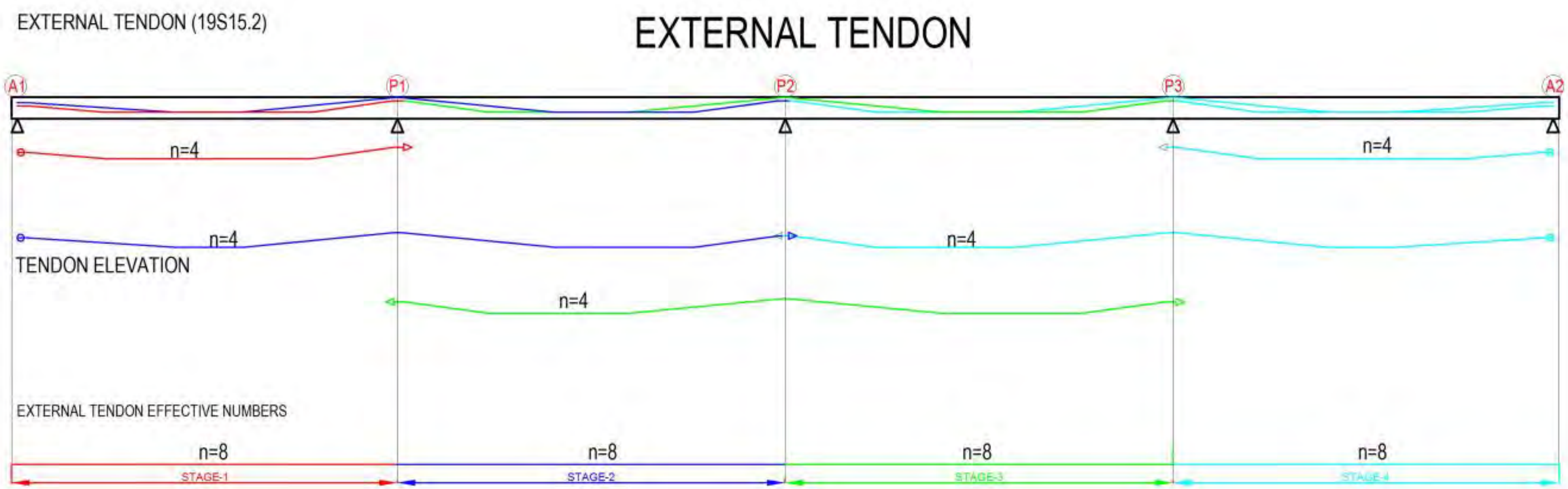
(3) PRESTRESSING TENDON

Tensile strength	:	1860.0 N/mm^2
Yeild strength	:	1600.0 N/mm^2
Young's modulus	:	2.00E+05 N/mm^2
Initial Slip	:	6.0 mm
Relaxaction	:	r_{1000} =1.5% loss ratio after 1000 hours due to steel relaxation
EXTERNAL TENDON		
Post Tension (Stress)	:	1250.0 N/mm^2
Tendon type	:	SWPR7BL, 19S15.2, Low relaxation
Cross section area	:	2635.3 mm^2
Curvature Friction Factor	:	0.3
INTERNAL TENDON		
Post Tension (Stress)	:	1350.0 N/mm^2
Tendon type	:	SWPR7BL, 12S15.2, Low relaxation
Cross section area	:	1664.4 mm^2
Tendon Duct Diameter	:	80.0 mm
Curvature Friction Factor	:	0.3
Wobble Friction Factor	:	0.004 /m

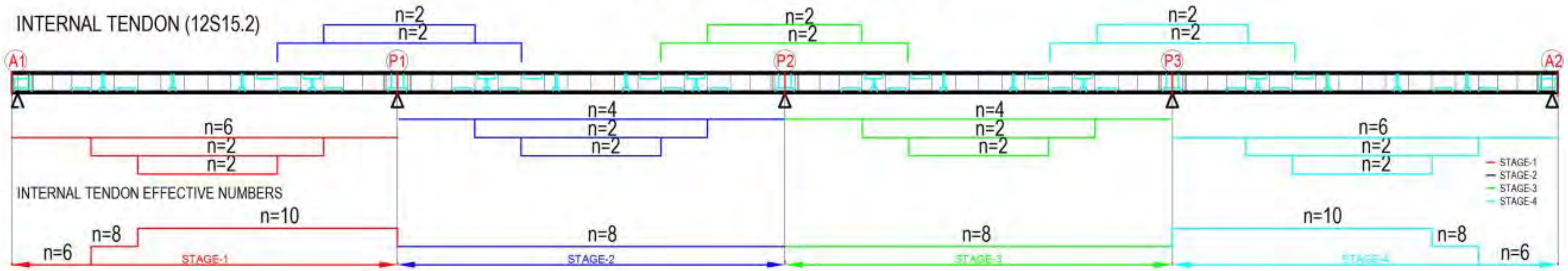
TRANSFER LENGTH (External)		**Begin (m)**	**End (m)**	**Tendon name**
Tendon Dead Anchorage	:	0.000	0.800	①②
,,	:	0.800	0.000	⑨⑩
Tendon one Side Pull	:	0.000	0.800	③④⑦⑧
Tendon Both Sides Pull	:	0.000	0.000	⑤⑥

TRANSFER LENGTH (Internal)		**Begin (m)**	**End (m)**	**Tendon name**
Tendon Dead Anchorage	:	0.000	2.801	1L1, 1L2, 1L3
,,	:	2.801	0.000	4L1, 4L2, 4L3
Tendon Both Sides Pull	:	0.000	2.801	2L1, 2L2
,,	:	0.000	0.000	3L1, 3L2
,,	:	2.400	2.400	1L4, 2L3, 3L3, 4L4
,,	:	2.646	2.646	1L5, 2L4, 4L5, 3L4
,,	:	2.651	2.651	1U1, 1U2, 2U1, 2U2, 3U1, 3U2

EXTERNAL TENDON



INTERNAL TENDON



2-3 ALLOWABLE STRESS

(1) CONCRETE

Table 3.2.2 Allowable compressive stress (N/mm^2) for prestressed concrete structure

Stress type \ Design standard strength of concrete			30	40	50	60
Immediately after prestressing	Bending compressive stress	1) Rectangular section	15.0	19.0	21.0	23.0
		2) T-shaped or box-shaped section	14.0	18.0	20.0	22.0
	3) Axial compressive stress		11.0	14.5	16.0	17.0
Others	Bending compressive stress	4) Rectangular section	12.0	15.0	17.0	19.0
		5) T-shaped or box-shaped section	11.0	14.0	16.0	18.0
	6) Axial compressive stress		8.5	11.0	13.5	15.0

Table 3.2.3 Allowable tensile stress (N/mm^2) for prestressed concrete structure

Stress type \ Design standard strength of concrete			30	40	50	60
Bending tensile stress	1) Immediately after prestressing		1.2	1.5	1.8	2.0
	2) Principal loads other than live load and impact		0	0	0	0
	Principal loads and special loads corresponding to "principal load"	3) Floor slab	0	0	0	0
		4) Segment joint of precast segment bridges	0	0	0	0
		5) Other cases	1.2	1.5	1.8	2.0
6) Axial tensile stress			0	0	0	0

Table 3.2.5 Allowable diagonal tensile stress (N/mm^2) for prestressed concrete structure

Stress type \ Design standard strength of concrete		30	40	50	60
Principal loads other than live load and impact	1) Case where shear force alone or torsional moment alone is to be considered	0.8	1.0	1.2	1.3
	2) Case where both shear force and torsional moment are to be considered	1.1	1.3	1.5	1.6
Combination of loads not considering collision load or the effects of earthquakes	3) Case where shear force alone or torsional moment alone is to be considered	1.7	2.0	2.3	2.5
	4) Case where both shear force and torsional moment are to be considered	2.2	2.5	2.8	3.0

(2) REINFORCEMENT

Table 3.3.1 Allowable stress (N/mm^2) of reinforcement

Stress and member type \ Reinforcement type			SR235	SD295A SD295B	SD345
Tensile stress	1) Principal loads other than live load and impact		80	100	100
	2) Reference value of allowable stress to be used when collision load or the effects of earthquakes are not considered in the combination of loads	General members	140	180	180
		Floor slab and slab bridges with a span of 10 m or less	140	140	140
	3) Reference value of allowable stress to be used when collision load or the effects of earthquakes are considered in the combination of loads		140	180	200
	4) Reference value of allowable stress to be used when calculating the lap joint length or bond length of reinforcement		140	180	200
5) Compressive stress			140	180	200

(3) PRESTRESSING TENDON

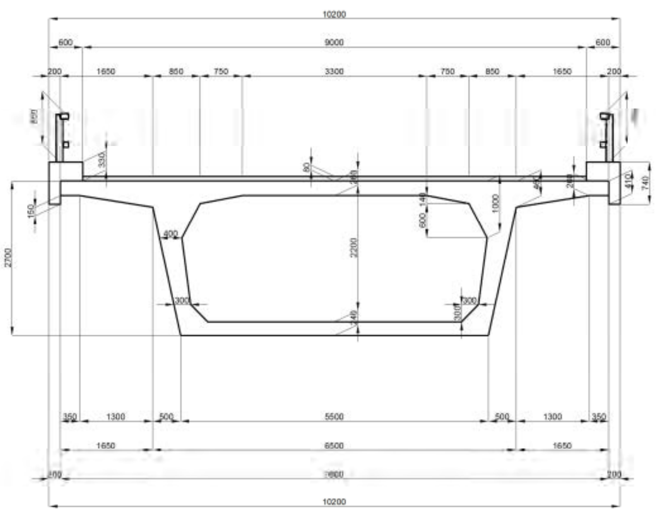
Table C. 3.4.1 Allowable tensile stress (N/mm^2) of PC tendon

PC tendon type \ Allowable tensile stress				During prestressing	Immediately after prestressing	Under design load
Steel wire	SWPR1AN SWPR1AL SWPD1N SWPD1L		5 mm	1260	1120	960
			7 mm	1170	1050	900
			8 mm	1125	1015	870
			9 mm	1080	980	840
	SWPR1BN SWPR1BL		5 mm	1350	1190	1020
			7 mm	1260	1120	960
			8 mm	1215	1085	930
Steel strand	SWPR2N SWPR2L		2.9 mm (2-strand wire)	1530	1365	1170
	SWPR7AN (7-strand wire) SWPR7AL (7-strand wire)			1305	1190	1020
	SWPR7BN (7-strand wire) SWPR7BL (7-strand wire)			1440	1295	1110
	SWPR19N SWPR19L (19-strand wire)		17.8 mm	1440	1295	1110
			19.3 mm	1440	1295	1110
			20.3 mm	1440	1260	1080
			21.8 mm	1440	1260	1080
			28.6 mm	1350	1260	1080
Steel bar	Round bar Type A	2	SBPR785/1030	706	667	588
	Round bar Type B	1	SBPR930/1080	837	756	648
		2	SBPR930/1180	837	790	697

Calculation of Cross-sectional Properties

Gross concrete section

CROSS SECTION @ 1-1



Element No.	Shape	Nos.	Dimension		Cross-sectional area	Distance from top of section to centroid	A • y' [m³]	A • y'² [m⁴]	Moment of Inertia
			Width	Height					
			b [m]	h [m]	A [m²]	y' [m]			I_0 [m⁴]
Total									

Cross-sectional area : $A_c = \sum A$

Centroid of section : $y_c{}' = \frac{\sum(A \cdot y')}{\sum A}$

From bottom to centroid of section : $y_c = -(H - y_c')$

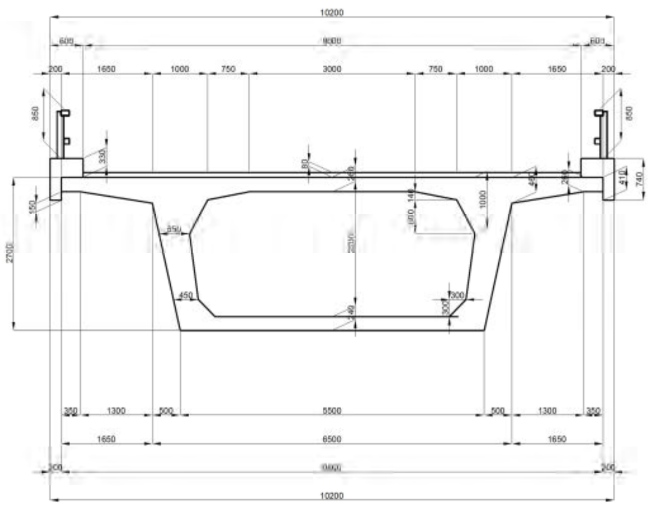
Moment of inertia : $I_c = \sum\left(A \cdot y'^2\right) + \sum I_0 - \sum A \cdot y_c{}'^2$

Section modulus

at top fiber : $Z_c{}' = \frac{I_c}{y_c{}'}$

at bottom fiber : $Z_c = \frac{I_c}{y_c}$

CROSS SECTION @ 2-2



Element No.	Shape	Nos.	Dimension		Cross-sectional area	Distance from top of section to centroid	A • y' [m³]	A • y'² [m⁴]	Moment of Inertia
			Width	Height					
			b [m]	h [m]	A [m²]	y' [m]			I_0 [m⁴]
Total									

Cross-sectional area : $A_c = \sum A$

Centroid of section : $y_c{}' = \frac{\sum(A \cdot y')}{\sum A}$

From bottom to centroid of section : $y_c = -(H - y_c')$

Moment of inertia : $I_c = \sum\left(A \cdot y'^2\right) + \sum I_0 - \sum A \cdot y_c{}'^2$

Section modulus

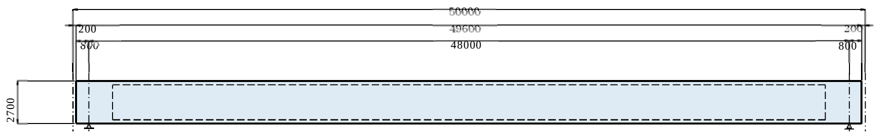
at top fiber : $Z_c{}' = \frac{I_c}{y_c{}'}$

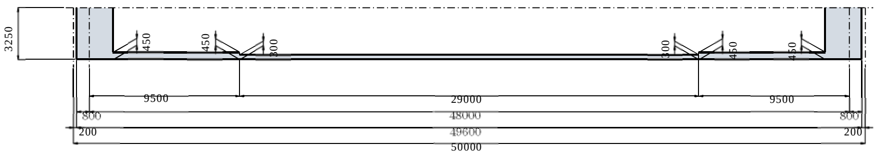
at bottom fiber : $Z_c = \frac{I_c}{y_c}$

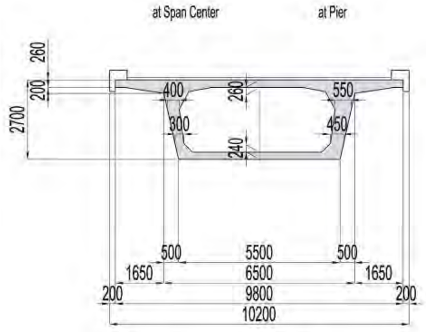
Calculation of Sectional Forces

Loads

1) Self-Weight







- At span center

A	=	_______	m^2
unit weight	=	24.5	kN/m^3
w	=	_______	kN/m

- At pier

A	=	_______	m^2
unit weight	=	24.5	kN/m^3
w	=	_______	kN/m

- Deviators, ribs, anchor blisters

w	=	8.0	kN/m (assumed)

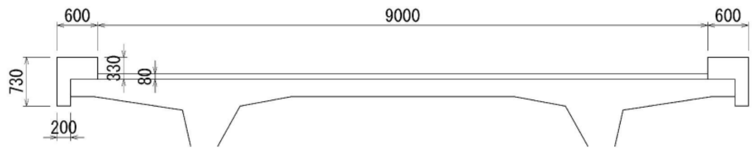
- Crossbeams at supports

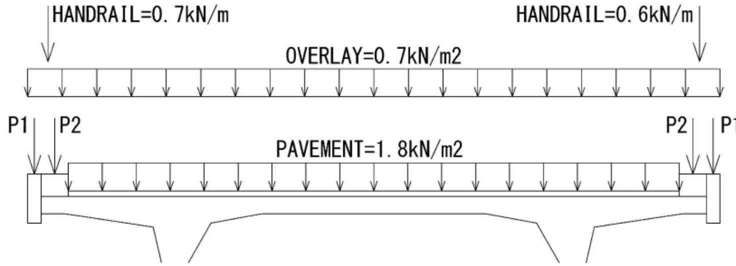
P	=	700.0	kN/EA (assumed)

Calculation of Sectional Forces

Loads

2) Superimposed Dead Load





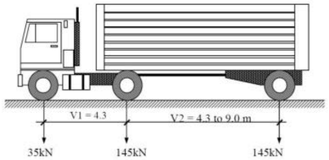
Pavement :	w =	_______	kN/m
Wheelguards: (per each)	w =		kN/m
	w x 2 =	_______	kN/m
Handrails :	w =	_______	kN/m
Overlay :	w =	_______	kN/m
Total	w =	_______	kN/m

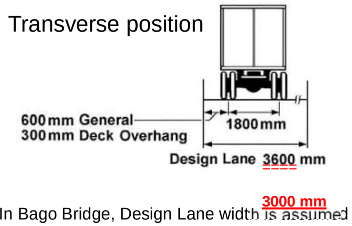
Calculation of Sectional Forces

Loads

3) Live Load

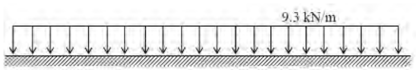
(1)-1 Design Truck





In Bago Bridge, Design Lane width is assumed to be **3000mm** to be on the safer side.

(2) Design lane load



(3) Multiple presence factor

Number of Loaded Lanes	Multiple Presence Factors, *m*
1	1.20
2	1.00
3	0.85
>3	0.65

Note: Nominal lane width is assumed to be 3.0m.

- Impact (dynamic allowance):

  i = 10 / (25 + L) = ________

  (assume L = 48.0m)
- Design truck:

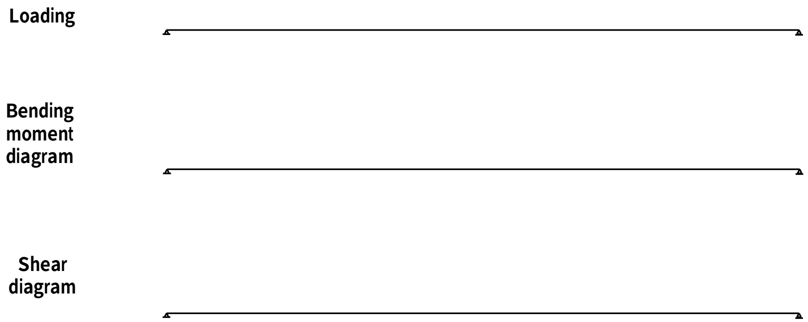
  P = (35 + 145 + 145) x 3 lanes x m x (1 + i) = ________ kN
- Design lane load :

  w = 9.3 x 3 lanes x m x (1 + i) = ________ kN

Calculation of Sectional Forces

Sectional Forces

1) Self-Weight



Calculation of Sectional Forces

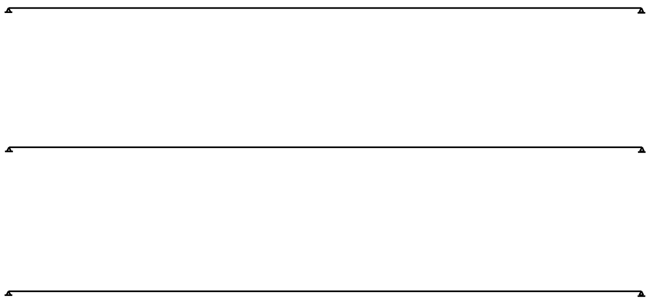
Sectional Forces

2) Superimposed Dead Load

Loading

Bending moment diagram

Shear diagram



Calculation of Sectional Forces

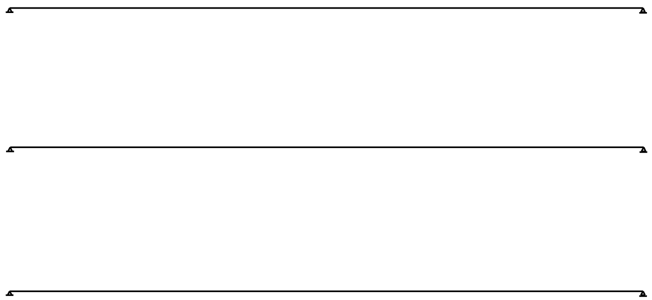
Sectional Forces

3) Live Load

Loading

Bending moment diagram

Shear diagram



Calculation of Sectional Forces

Sectional forces

Summary of sectional forces due to loads

	at Span center	at Support
	Bending moment	Shear
	[kNm]	[kN]
Self-weight		
Superimposed dead load		
Live load		
All dead loads		
Dead loads + live load		

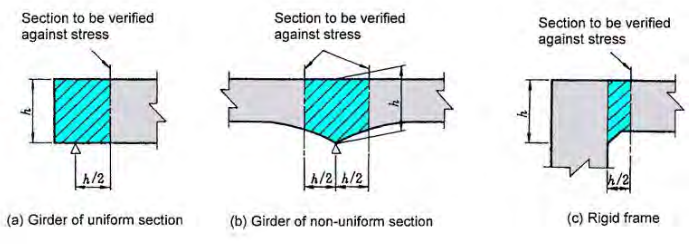


Figure 4.3.2 Section to be verified against shear force

(4), (5) Near a support of a girder and near a joint of a rigid frame, a compressive force due to support reaction acts on the web, so the tensile force acting on the diagonal tensile reinforcement is smaller than in the other portions. Therefore, the verification against shear force need not be performed in the area from the support to half the member height, and it is sufficient to place diagonal tensile reinforcement in the hatched area of Figure 4.3.2 in an such an amount that the member section satisfies the verification in Clauses (1) and (2) against the shear force at the distance of half the member height from the support.

Calculation of Bending Stress

1) Sectional Forces and stresses due to loads

	Bending moment	Section modulus		Stress due to loads	
		at top	at bottom	at top	at bottom
	M_d [kNm]	Z_c' [mm^3]	Z_c' [mm^3]	σ_d' [N/mm^2]	σ_d [N/mm^2]
Self-weight					
Superimposed dead load					
Live load					
All dead loads					
Dead loads + live load					

2) Calculation of Required Prestress

$$\sigma = \left(\frac{N}{A} + \frac{M}{Z}\right) + P\left(\frac{1}{A} + \frac{e_p}{Z}\right)$$

Where

σ : Resultant stress

$\left(\frac{N}{A} + \frac{M}{Z}\right)$: Stress due to loads (axial force + flexure)

$P\left(\frac{1}{A} + \frac{e_p}{Z}\right)$: Stress due to prestressing (total prestress x (axial force + flexure))

A : Cross-sectional area of the section

Z : Section modulus

N, M : Axial force and bending moment at the section

P : Total prestressing force

e_p : Eccentricity of tendons from centroid of the section

- For required prestress : P_e and allowable tensile stress of concrete : σ_{ca}' ,

$$\Sigma\sigma_c + \frac{P_e}{A_c} + \frac{P_e \cdot e_p}{Z} \geqq \sigma_{ca}'$$

Where

$\Sigma\,\sigma_c$: Total stress due to loads at extreme tensile fiber

σ_{ca}' : Allowable tensile stress of concrete

- The above expression is transformed to obtain P_e,

$$\frac{P_e}{A_c}\left(1 + \frac{A_c \cdot e_p}{\frac{I_c}{y_c}}\right) \geqq -\Sigma\sigma_c + \sigma_{ca}' \quad \rightarrow \quad \frac{P_e}{A_c}\left(1 + \frac{y_c}{r_c^2} \cdot e_p\right) \geqq -\Sigma\sigma_c + \sigma_{ca}'$$

Hence, $P_e = \frac{(-\Sigma\sigma_c + \sigma_{ca}') \cdot A_c}{1 + \frac{y_c}{r_c^2} e_p}$

Where

e_p : Eccentricity of centroid of tendons from centroid of the section

I_c : Moment of inertia of the section

A_c : Cross-sectional area of the section

y_c ' : Distance from centroid to extreme tensile fiber of the section

Z : Section modulus (= I/y_c)

r_c : Radius of gyration (= $\sqrt{I_c/A_c}$)

- Required number of tendons can be initially estimated assuming

$\sigma_{pe} \fallingdotseq 0.5\,\sigma_{pu}$ (for tendons using strands)

Where

σ_{pe} : Assumed effective prestress

σ_{pu} : Tensile strength of prestressing steel

P_e = $A_p \cdot \sigma_{pe}$ = = ____________ kN / tendon

(Tendon type : _______ , A_p = mm2 / tendon,

Pe _______ kN/tendon (assumed))

Calculation of Bending Stress

3) Resultant Stress

- At span center

		Immediately after anchor set		At service load state	
		at top	at bottom	at top	at bottom
		σ_u [N/mm²]	σ_l [N/mm²]	σ_u [N/mm²]	σ_l [N/mm²]
Internal prestress	immediately after anchor-set				
	Effective prestress				
External prestress	immediately after anchor-set				
	Effective prestress				
Total prestress	immediately after anchor-set				
	Effective prestress				
Self-weight					
Superimposed dead load					
Live load					
Immediately after anchor set					
All dead loads					
Dead loads + Live load					
Allowable stress σ_a [N/mm²]	compression	20.00	20.00	16.00	16.00
	tension	0.00	0.00	0.00	0.00

Load Combinations for Design

Concrete Bridges, JRA Specifiction

Load Combination Load State		D0 (Self-weight)	D1 (Superimposed Dead Load)	2P (Secondary Prestress)	SH (Shrinkage)	CR (Creep)	L (Live Load w/ impact)	T (Temperature Change)	DT (Differential Temperature)	PS (Prestress)
Immediately after prestressing		1.0		1.0 (Immediately after prestressing)						1.0 (Immediately after prestressing)
Service Load State	All dead loads (D)	1.0	1.0	1.0 (Effective prestress)	1.0	1.0				1.0 (Effective prestress)
	D + L	1.0	1.0	1.0 (Effective prestress)	1.0	1.0	1.0 (maximum & minimum)			1.0 (Effective prestress)
	D + L + T	1.0	1.0	1.0 (Effective prestress)	1.0	1.0	1.0 (maximum & minimum)	1.0 (rise & fall)	0.0 / 1.0	1.0 (Effective prestress)
Ultimate Load State	(a)	1.3	1.3	1.0	1.0	1.0	2.5 (maximum & minimum)			1.0 (Effective prestress)
	(b)	1.0	1.0	1.0	1.0	1.0	2.5 (maximum & minimum)			1.0 (Effective prestress)
	(c)	1.7	1.7	1.0	1.0	1.0	1.7 (maximum & minimum)			1.0 (Effective prestress)

Stress Increase in External Tendons at ULS

(Specified in "Design Guidelines Part-2: Bridge Construction" by NEXCO, Japan)

When L/dp ＞ 50, $\Delta\sigma p = 0$ (N/mm2) 式 (8-2-3)

When L/dp ≦ 50, $\Delta\sigma p = k \times dp / L < \Delta\sigma pmax$ (N/mm2) 式 (8-2-4)

Where, L : Distance between anchorages of the external tendon [mm]

dp : Effective depth of the external tendon (from extreme compressive fiber to the centroid of the tendon) [mm]

k : Coefficient related to tendon type, section location and type of webs [N/mm2]

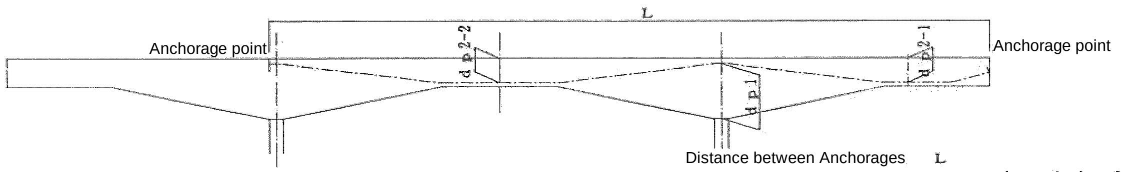
$\Delta\sigma pmax$: Upper limit corresponding to type of structure and tendon

Table 8-2-7 Value of k, Δσpmax

			Concrete Webs		Corrugated Steel Webs	
Structure	Type of Tendon	Section Location	k	⊿σ pmax	k	⊿σ pmax
Rigid Frame	Cantilever Tendon	Center Span	1, 200	350	1, 500	400
		Side Span			1, 000	200
	Continuous Tendon	Center Span	4, 000	400	4, 000	400
		Side Span				
Continuous Girder	Cantilever Tendon	Center Span	1, 200	350	1, 500	400
		Side Span			1, 000	200
	Continuous Tendon	Center Span	4, 000	450	4, 000	400
		Side Span			2, 000	

Effective Depth of External Tendon

For continuous tendons

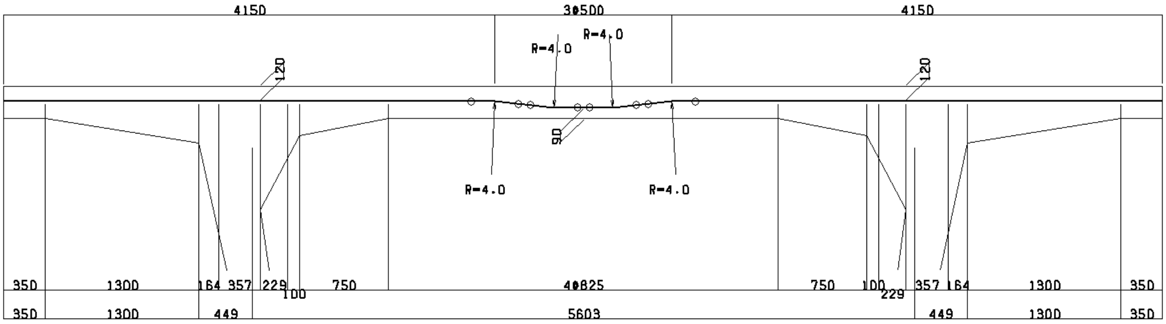


Distance between Anchorages L

Effective Depth $d p = \frac{d p 1 + d p 2}{2}$

For multiple dp2s (more than 2 nos), their avarage value is applied. $d p 2 = \frac{d p 2-1 + d p 2-2}{2}$

Transverse Prestressing of Deck Slab



0.010	0.010	0.110	0.137	0.111	0.089	0.080	0.010	0.008	-0.040	0.008	0.010	0.080	0.089	0.111	0.137	0.110	0.010	0.010	ep (m)
0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.122	0.170	0.122	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	yp (m)
0.260	0.260	0.460	0.515	0.462	0.419	0.400	0.260	0.260	0.260	0.260	0.260	0.400	0.419	0.462	0.515	0.460	0.260	0.260	tu (m)

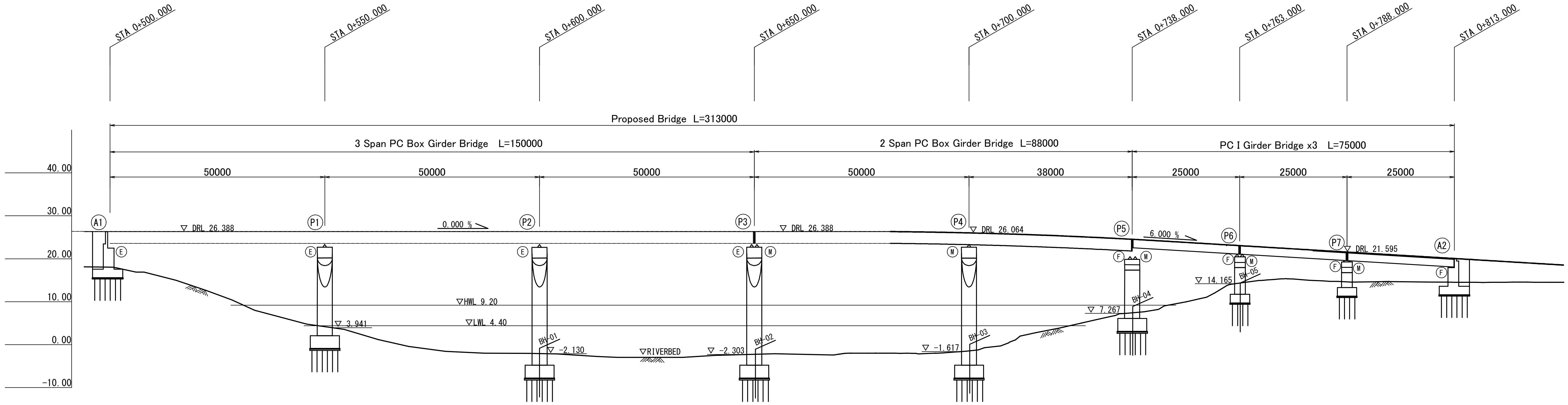
Type	=	Strand Cable 3S12.7
Stressing	=	One side (Alternation)
σpt0	=	1350.0 N/mm2
λ	=	0.004
μ	=	0.300

Appendix A Materials of Lectures and Seminars

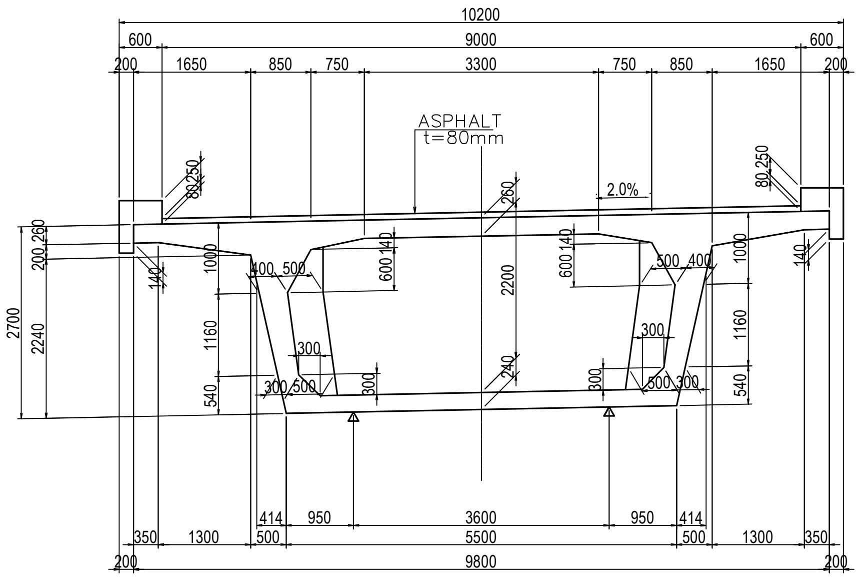
A-11 Detailed Practice for Foundation & Substructure

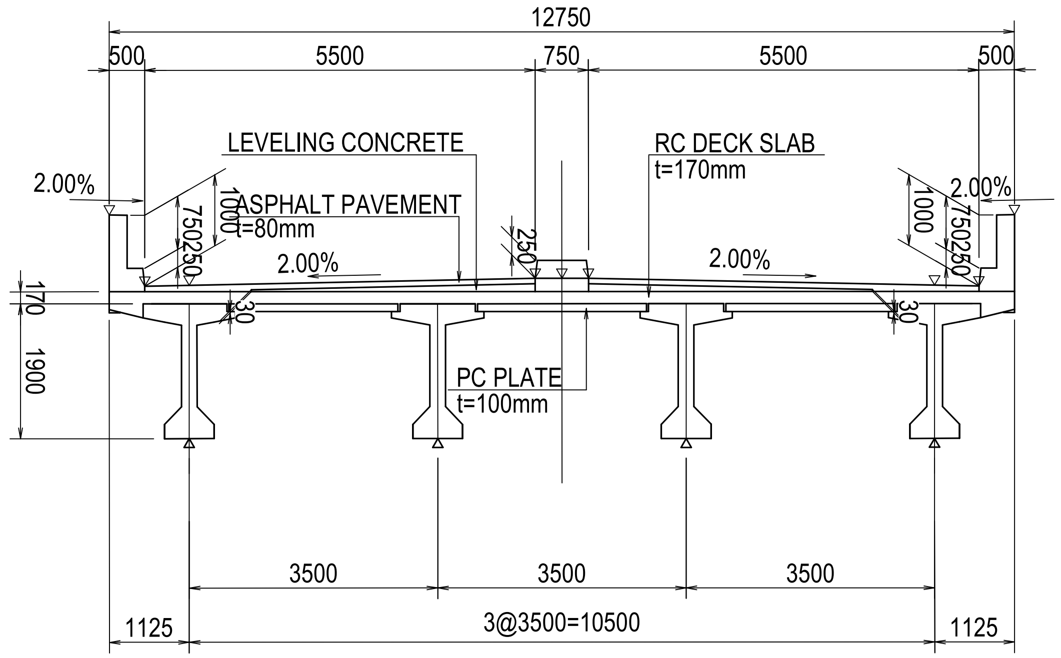
GENERAL VIEW OF THE BRIDGE

SIDE VIEW



CROSS SECTION OF SUPERSTRUCTURES





Notes:	Client	Consultant	Approved		Project:		
			Checked		Job:		
			Designed		Scale:		

Superstructure Reaction Force (For Substructure design)

	P2			P3 (B.P. side)			P3 (E.P. side)			P4		
	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)
Selfweight	13,000.0	0.0	0.0	6,600.0	0.0	0.0	6,600.0	0.0	0.0	11,620.0	0.0	0.0
Superimposed load	6,000.0	0.0	0.0	3,000.0	0.0	0.0	3,000.0	0.0	0.0	5,280.0	0.0	0.0
Dead Load all	19,000.0	0.0	0.0	9,600.0	0.0	0.0	9,600.0	0.0	0.0	16,900.0	0.0	0.0
Live Load (Max)	5,000.0	0.0	0.0	3,500.0	0.0	0.0	3,500.0	0.0	0.0	5,000.0	0.0	0.0
Live Load (Min)	-800.0	0.0	0.0	-400.0	0.0	0.0	-500.0	0.0	0.0	-700.0	0.0	0.0
Dead + Live (Max)	24,000.0	0.0	0.0	13,100.0	0.0	0.0	13,100.0	0.0	0.0	21,900.0	0.0	0.0
Dead + Live (Min)	18,200.0	0.0	0.0	9,200.0	0.0	0.0	9,100.0	0.0	0.0	16,200.0	0.0	0.0
Seismic Effeict (Bridge Axial)	19,000.0	5,700.0	0.0	9,600.0	2,850.0	0.0	9,600.0	2,700.0	0.0	16,900.0	5,060.0	0.0
Seismic Effeict (Transverse)	19,000.0	6,000.0	0.0	9,600.0	2,550.0	0.0	9,600.0	2,500.0	0.0	16,900.0	5,300.0	0.0

	P5 (B.P. side)			P5 (E.P. side)			P6 (B.P. side)			P6 (E.P. side)		
	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)
Selfweight	5,020.0	0.0	0.0	4,500.0	0.0	0.0	4,500.0	0.0	0.0	4,500.0	0.0	0.0
Superimposed load	2,280.0	0.0	0.0	2,000.0	0.0	0.0	2,000.0	0.0	0.0	2,000.0	0.0	0.0
Dead Load all	7,300.0	0.0	0.0	6,500.0	0.0	0.0	6,500.0	0.0	0.0	6,500.0	0.0	0.0
Live Load (Max)	3,000.0	0.0	0.0	2,500.0	0.0	0.0	2,500.0	0.0	0.0	2,500.0	0.0	0.0
Live Load (Min)	-500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dead + Live (Max)	10,300.0	0.0	0.0	9,000.0	0.0	0.0	9,000.0	0.0	0.0	9,000.0	0.0	0.0
Dead + Live (Min)	6,800.0	0.0	0.0	6,500.0	0.0	0.0	6,500.0	0.0	0.0	6,500.0	0.0	0.0
Seismic Effeict (Bridge Axial)	7,300.0	2,350.0	0.0	6,500.0	390.0	0.0	6,500.0	3,510.0	0.0	6,500.0	390.0	0.0
Seismic Effeict (Transverse)	7,300.0	2,310.0	0.0	6,500.0	1,950.0	0.0	6,500.0	1,950.0	0.0	6,500.0	1,950.0	0.0

Superstructure Reaction Force (For design of bearings/beam)

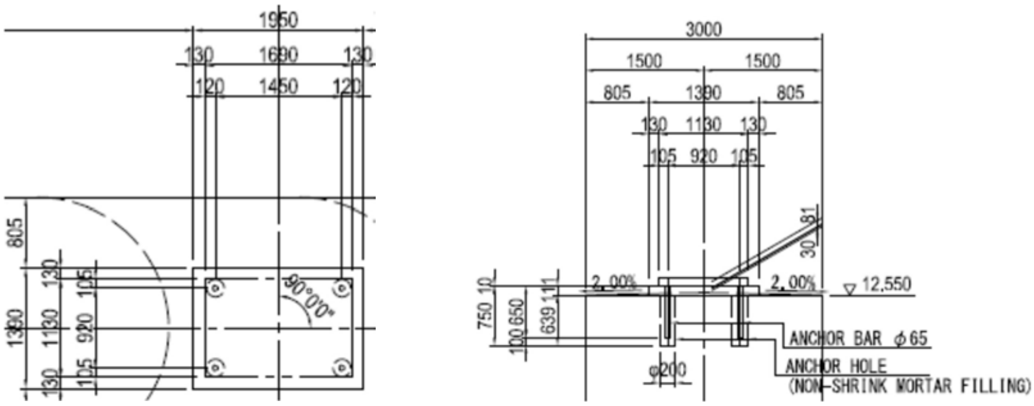
	P2			P3 (B.P. side)			P3 (E.P. side)			P4			P5 (B.P. side)		
	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)
Selfweight	6,500.0	6,500.0	13,000.0	3,300.0	3,300.0	6,600.0	3,300.0	3,300.0	6,600.0	5,810.0	5,810.0	11,620.0	2,510.0	2,510.0	5,020.0
Superimposed load	3,000.0	3,000.0	6,000.0	1,500.0	1,500.0	3,000.0	1,500.0	1,500.0	3,000.0	2,640.0	2,640.0	5,280.0	1,140.0	1,140.0	2,280.0
Dead Load all	9,500.0	9,500.0	19,000.0	4,800.0	4,800.0	9,600.0	4,800.0	4,800.0	9,600.0	8,450.0	8,450.0	16,900.0	3,650.0	3,650.0	7,300.0
Live Load (Max)	3,500.0	3,500.0	–	2,400.0	2,400.0	–	2,400.0	2,400.0	–	3,500.0	3,500.0	–	2,000.0	2,000.0	–
Live Load (Min)	-500.0	-500.0	–	-300.0	-300.0	–	-300.0	-300.0	–	-500.0	-500.0	–	-300.0	-300.0	–
Dead + Live (Max)	13,000.0	13,000.0	–	7,200.0	7,200.0	–	7,200.0	7,200.0	–	11,950.0	11,950.0	–	5,650.0	5,650.0	–
Dead + Live (Min)	9,000.0	9,000.0	–	4,500.0	4,500.0	–	4,500.0	4,500.0	–	7,950.0	7,950.0	–	3,350.0	3,350.0	–

	P5 (E.P. side)					P6 (B.P. side)					P6 (E.P. side)				
	SL Rz (kN)	SCL Rz (kN)	SCR Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SCL Rz (kN)	SCR Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SCL Rz (kN)	SCR Rz (kN)	SR Rz (kN)	Sum Rz (kN)
Selfweight	1,200.0	1,050.0	1,050.0	1,200.0	4,500.0	1,200.0	1,050.0	1,050.0	1,200.0	4,500.0	1,200.0	1,050.0	1,050.0	1,200.0	4,500.0
Superimposed load	550.0	450.0	450.0	550.0	2,000.0	550.0	450.0	450.0	550.0	2,000.0	550.0	450.0	450.0	550.0	2,000.0
Dead Load all	1,750.0	1,500.0	1,500.0	1,750.0	6,500.0	1,750.0	1,500.0	1,500.0	1,750.0	6,500.0	1,750.0	1,500.0	1,500.0	1,750.0	6,500.0
Live Load (Max)	850.0	950.0	950.0	850.0	–	850.0	950.0	950.0	850.0	–	850.0	950.0	950.0	850.0	–
Live Load (Min)	600.0	700.0	700.0	600.0	–	600.0	700.0	700.0	600.0	–	600.0	700.0	700.0	600.0	–
Dead + Live (Max)	2,600.0	2,450.0	2,450.0	2,600.0	–	2,600.0	2,450.0	2,450.0	2,600.0	–	2,600.0	2,450.0	2,450.0	2,600.0	–
Dead + Live (Min)	2,350.0	2,200.0	2,200.0	2,350.0	–	2,350.0	2,200.0	2,200.0	2,350.0	–	2,350.0	2,200.0	2,200.0	2,350.0	–

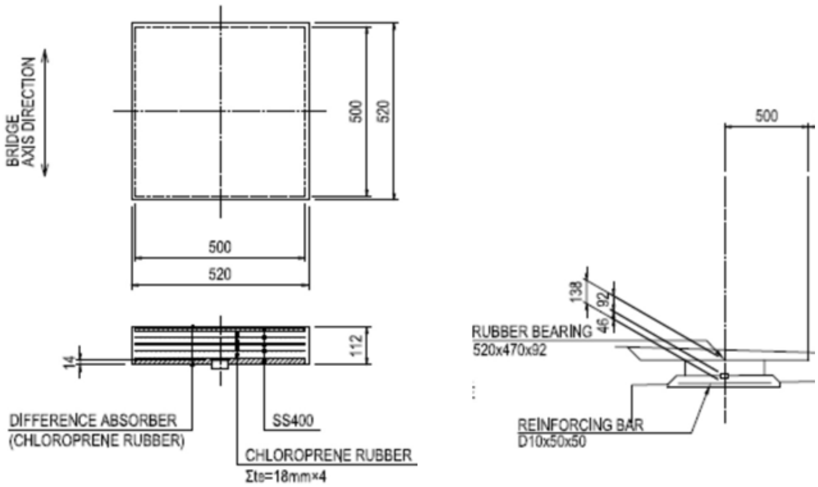
Design Practice for “Pier with Cast-in-place RC pile”

1. Bearing details

- PC BOX Girder Bridge
  (A1 / P1 / P2 / P3 at B.P. side / P3 at E.P. side / P4 / P5 at B.P. side)



- PC I Girder Bridge
  (P5 at E.P. side / P6 at B.P. side / P6 at E.P. side / P7 at B.P. side / P7 at E.P. side / A2)

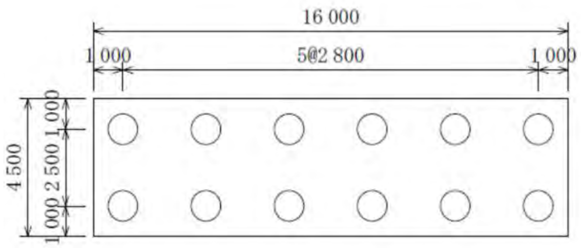
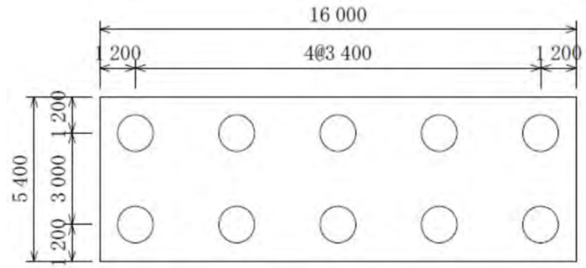
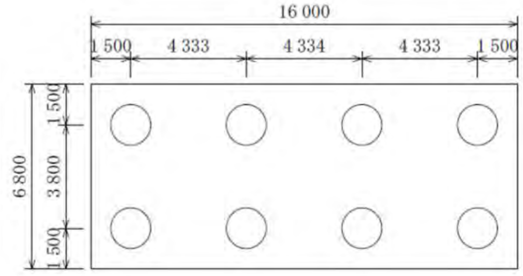


2. Required joint gap

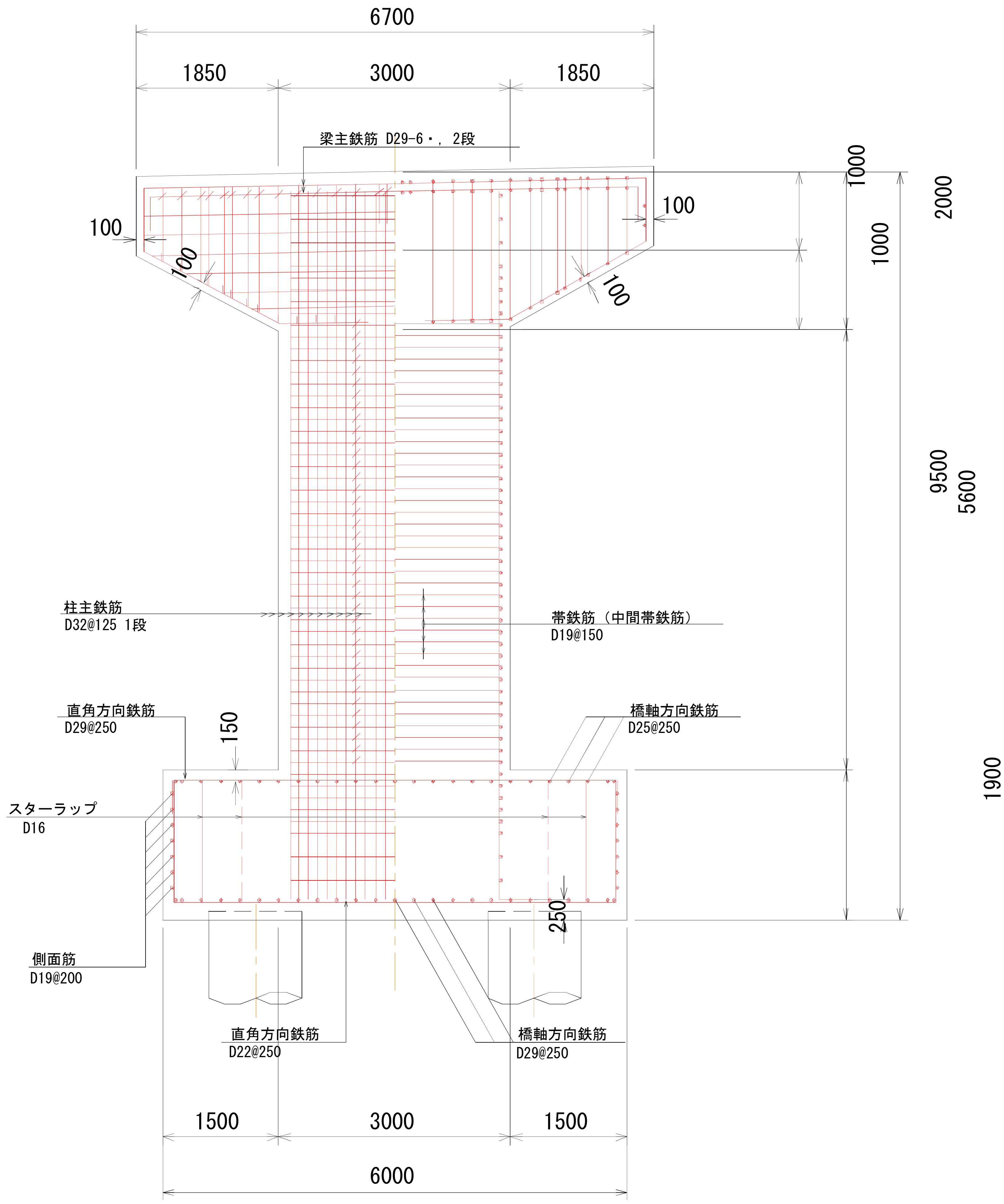
Location	Joint gap
P3/P5	250mm
A1	200mm
P6/P7	150mm
A2	100mm

A Comparison in Pile Diameter and Numbers (Example)

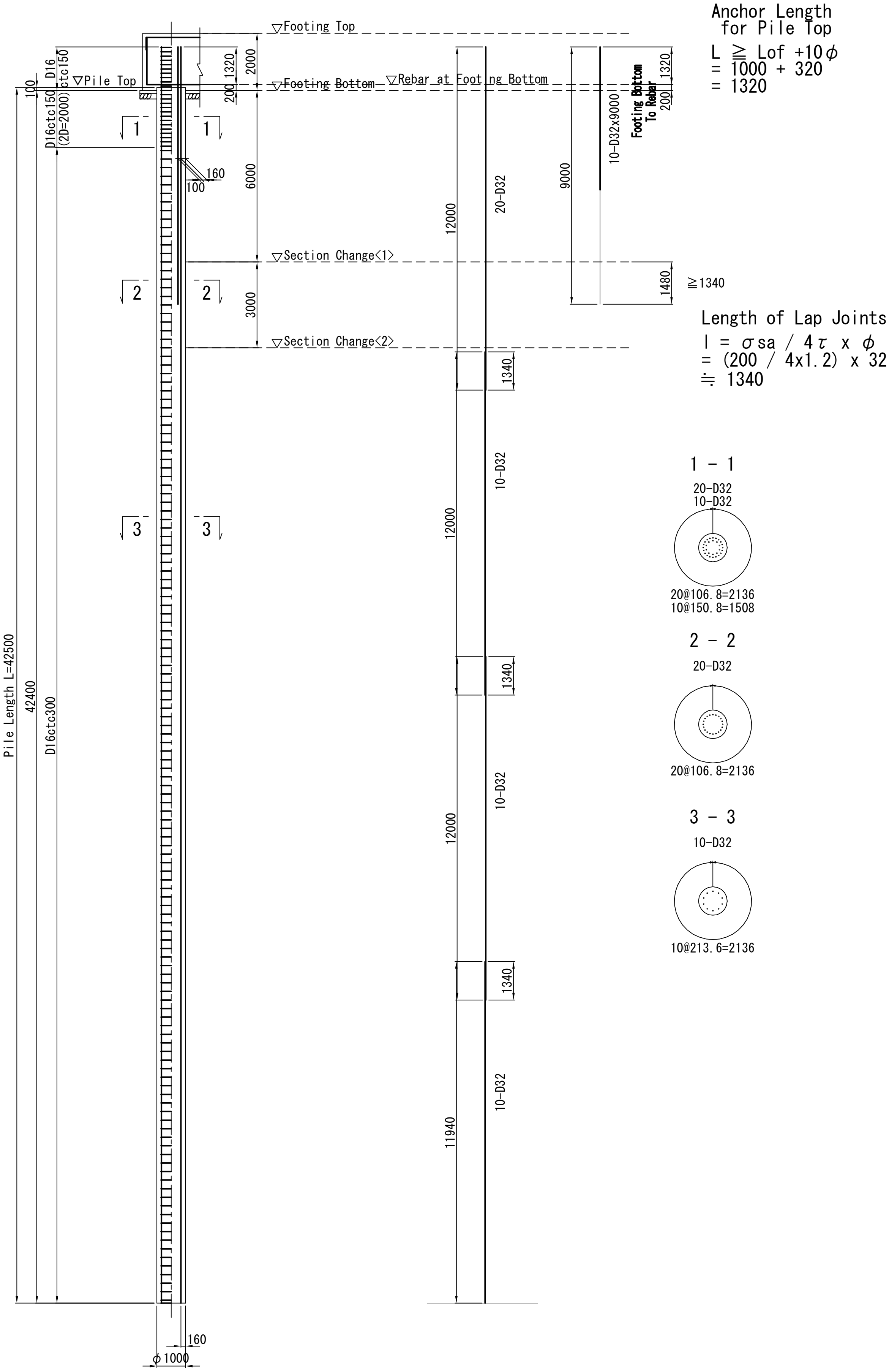
Pile type : Cast in placed RC pile

No.	1				2				3			
Arrangement Plan	 Pile Diameter : ϕ=1.0m Pile Number 2x6=12 Pile Length : 39.0m				 Pile Diameter : ϕ=1.2m Pile Number 2x5=10 Pile Length : 39.0m				 Pile Diameter : ϕ=1.5m Pile Number 2x4=8 Pile Length : 39.0m			
Main Rebar (1st section)	1st low : D29 − 20 (@107mm) 2nd low : D29 − 16 (@118mm)				1st low : D25 − 24 (@118mm)				1st low : D25 − 30 (@126mm)			
External Force	Ordinary Load Case (D + L)		Seismic Load Case		Ordinary Load Case (D + L)		Seismic Load Case		Ordinary Load Case (D + L)		Seismic Load Case	
	Vo (kN)	29657.3	Vo (kN)	26963.3	Vo (kN)	30636.5	Vo (kN)	27942.5	Vo (kN)	32159.7	Vo (kN)	29465.7
	Ho (kN)	0	Ho (kN)	3538.6	Ho (kN)	0	Ho (kN)	3644.4	Ho (kN)	0	Ho (kN)	3809.1
	Mo (kN・m)	0	Mo (kN・m)	20822.1	Mo (kN・m)	0	Mo (kN・m)	20928.0	Mo (kN・m)	0	Mo (kN・m)	21092.6
Stability Check	δ (mm)	0.0 ≦ 15.0	δ (mm)	12.72 ≦ 15.00	δ (mm)	0.0 ≦ 15.0	δ (mm)	12.08 ≦ 15.00	δ (mm)	0.0 ≦ 15.0	δ (mm)	11.45 ≦ 15.00
	Pmax (kN/pile)	2471.4 ≦ 2933.0	Pmax (kN/pile)	3759.6 ≦ 4479.0	Pmax (kN/pile)	3063.7 ≦ 3511.0	Pmax (kN/pile)	4391.5 ≦ 5383.0	Pmax (kN/pile)	4020.0 ≦ 4375.0	Pmax (kN/pile)	5404.4 ≦ 6743.0
	Pmin (kN/pile)	2471.4 ≧ 0.0	Pmin (kN/pile)	734.3 ≧ −3415.0	Pmin (kN/pile)	3063.7 ≧ 0.0	Pmin (kN/pile)	1197.0 ≧ −4206.0	Pmin (kN/pile)	4020.0 ≧ 0.0	Pmin (kN/pile)	1962.0 ≧ −5460.0
Approximate Cost (Pile)	Item	Quantity	Unit Cost (USD)	Amount (USD)	Item	Quantity	Unit Cost	Amount (USD)	Item	Quantity	Unit Cost	Amount (USD)
	Concrete (m3)	367.4	83.4	30,641.2	Concrete (m3)	440.9	83.4	36,771.1	Concrete (m3)	551.1	83.4	45,961.7
	Re-bar (t)	41.6	731.9	30,447.0	Re-bar (t)	29.0	731.9	21,225.1	Re-bar (t)	31.3	731.9	22,908.5
	Works		Assumed as 10% of material cost	6,108.8	Works		Assumed as 10% of material cost	5,799.6	Works		Assumed as 10% of material cost	6,887.0
			Sub-Total	67,197.0			Sub-Total	63,795.8			Sub-Total	75,757.2
Approximate Cost (Footing)	Concrete (m3)	144.0	103.5	14,904.0	Concrete (m3)	172.8	103.5	17,884.8	Concrete (m3)	217.6	103.5	22,521.6
	Re-bar (t)	14.4	731.9	10,539.4	Re-bar (t)	17.3	731.9	12,661.9	Re-bar (t)	21.8	731.9	15,955.4
	Works		Assumed as 10% of material cost	2,544.3	Works		Assumed as 10% of material cost	3,054.7	Works		Assumed as 10% of material cost	3,847.7
			Sub-Total	27,987.7			Sub-Total	33,601.3			Sub-Total	42,324.7
Total Approx.Cost	95,000				97,000				118,000			
Recommendation	✔											

Rebar Arrangement Plan of Pier (Sample)

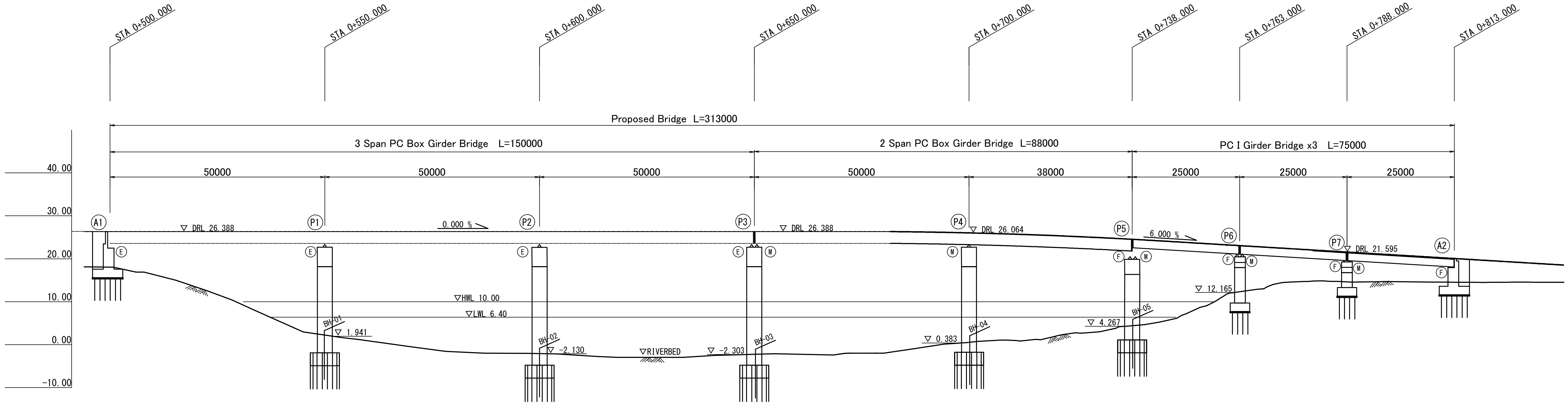


Reinforcement Arrangement Plan
Cast-in-place RC pile ϕ1000

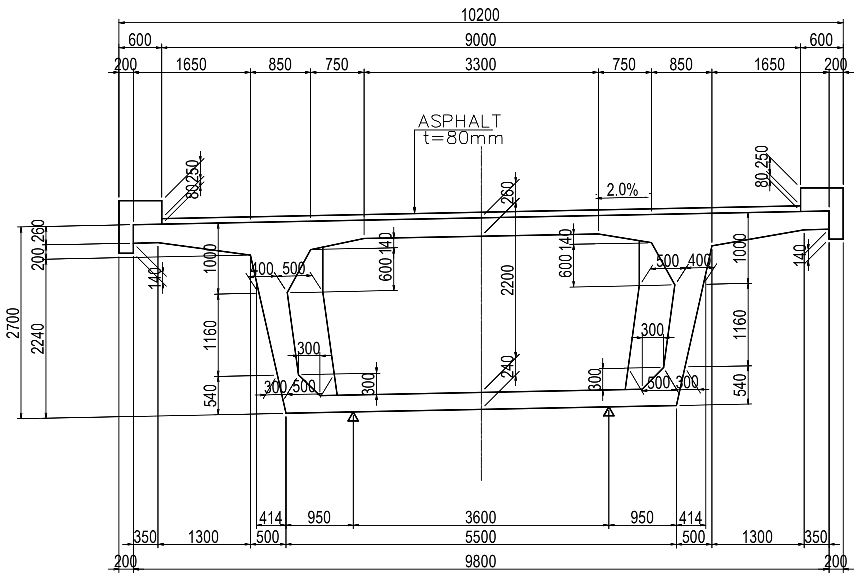


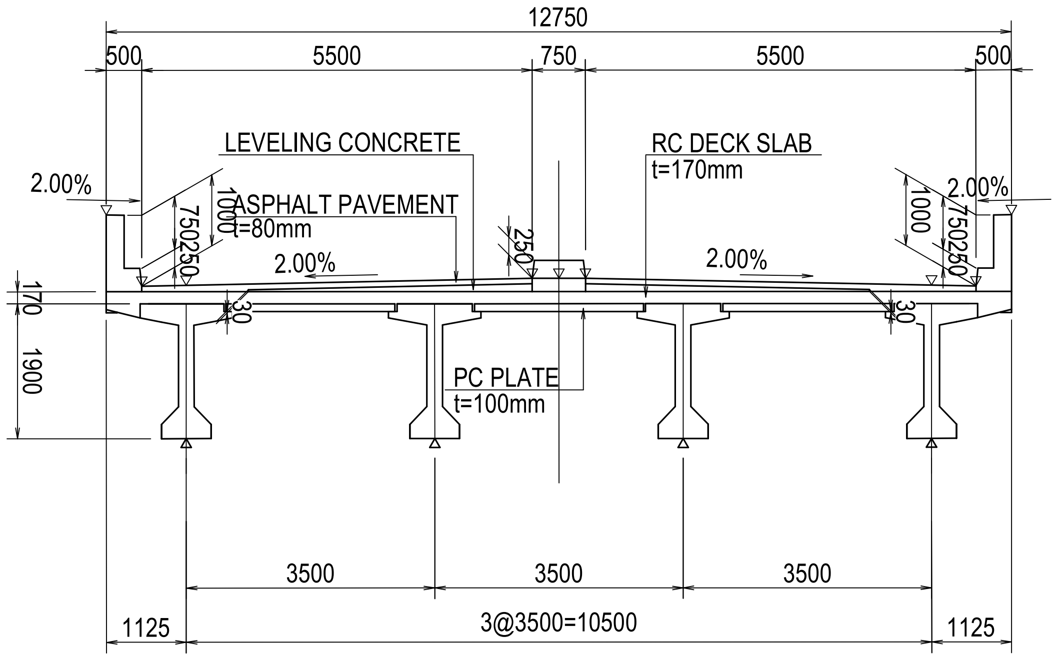
GENERAL VIEW OF THE BRIDGE (2)

SIDE VIEW



CROSS SECTION OF SUPERSTRUCTURES





Notes:	Client	Consultant	Approved		Project:		
			Checked		Job:		
			Designed		Scale:		

Superstructure Reaction Force 2 (For Substructure design)

	P1			P2			P3 (B.P. side)			P3 (E.P. side)		
	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)
Selfweight	13,000.0	0.0	0.0	13,000.0	0.0	0.0	6,600.0	0.0	0.0	6,600.0	0.0	0.0
Superimposed load	6,000.0	0.0	0.0	6,000.0	0.0	0.0	3,000.0	0.0	0.0	3,000.0	0.0	0.0
Dead Load all	19,000.0	0.0	0.0	19,000.0	0.0	0.0	9,600.0	0.0	0.0	9,600.0	0.0	0.0
Live Load (Max)	5,000.0	0.0	0.0	5,000.0	0.0	0.0	3,500.0	0.0	0.0	3,500.0	0.0	0.0
Live Load (Min)	-800.0	0.0	0.0	-800.0	0.0	0.0	-400.0	0.0	0.0	-500.0	0.0	0.0
Dead + Live (Max)	24,000.0	0.0	0.0	24,000.0	0.0	0.0	13,100.0	0.0	0.0	13,100.0	0.0	0.0
Dead + Live (Min)	18,200.0	0.0	0.0	18,200.0	0.0	0.0	9,200.0	0.0	0.0	9,100.0	0.0	0.0
Seismic Effeict (Bridge Axial)	19,000.0	5,700.0	0.0	19,000.0	5,700.0	0.0	9,600.0	2,850.0	0.0	9,600.0	2,700.0	0.0
Seismic Effeict (Transverse)	19,000.0	6,000.0	0.0	19,000.0	6,000.0	0.0	9,600.0	2,550.0	0.0	9,600.0	2,500.0	0.0

	P4			P5 (B.P. side)			P5 (E.P. side)					
	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)	V (kN)	H (kN)	M (kN)			
Selfweight	11,620.0	0.0	0.0	5,020.0	0.0	0.0	4,500.0	0.0	0.0			
Superimposed load	5,280.0	0.0	0.0	2,280.0	0.0	0.0	2,000.0	0.0	0.0			
Dead Load all	16,900.0	0.0	0.0	7,300.0	0.0	0.0	6,500.0	0.0	0.0			
Live Load (Max)	5,000.0	0.0	0.0	3,000.0	0.0	0.0	2,500.0	0.0	0.0			
Live Load (Min)	-700.0	0.0	0.0	-500.0	0.0	0.0	0.0	0.0	0.0			
Dead + Live (Max)	21,900.0	0.0	0.0	10,300.0	0.0	0.0	9,000.0	0.0	0.0			
Dead + Live (Min)	16,200.0	0.0	0.0	6,800.0	0.0	0.0	6,500.0	0.0	0.0			
Seismic Effeict (Bridge Axial)	16,900.0	5,060.0	0.0	7,300.0	2,350.0	0.0	6,500.0	390.0	0.0			
Seismic Effeict (Transverse)	16,900.0	5,300.0	0.0	7,300.0	2,310.0	0.0	6,500.0	1,950.0	0.0			

Superstructure Reaction Force 2 (For design of bearings/beam)

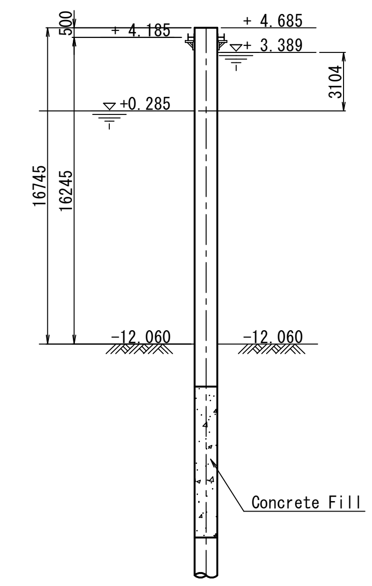
	P1			P2			P3 (B.P. side)			P3 (E.P. side)		
	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)
Selfweight	6,500.0	6,500.0	13,000.0	6,500.0	6,500.0	13,000.0	3,300.0	3,300.0	6,600.0	3,300.0	3,300.0	6,600.0
Superimposed load	3,000.0	3,000.0	6,000.0	3,000.0	3,000.0	6,000.0	1,500.0	1,500.0	3,000.0	1,500.0	1,500.0	3,000.0
Dead Load all	9,500.0	9,500.0	19,000.0	9,500.0	9,500.0	19,000.0	4,800.0	4,800.0	9,600.0	4,800.0	4,800.0	9,600.0
Live Load (Max)	3,500.0	3,500.0	-	3,500.0	3,500.0	-	2,400.0	2,400.0	-	2,400.0	2,400.0	-
Live Load (Min)	-500.0	-500.0	-	-500.0	-500.0	-	-300.0	-300.0	-	-300.0	-300.0	-
Dead + Live (Max)	13,000.0	13,000.0	-	13,000.0	13,000.0	-	7,200.0	7,200.0	-	7,200.0	7,200.0	-
Dead + Live (Min)	9,000.0	9,000.0	-	9,000.0	9,000.0	-	4,500.0	4,500.0	-	4,500.0	4,500.0	-

	P4			P5 (B.P. side)			P5 (E.P. side)				
	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SR Rz (kN)	Sum Rz (kN)	SL Rz (kN)	SCL Rz (kN)	SCR Rz (kN)	SR Rz (kN)	Sum Rz (kN)
Selfweight	5,810.0	5,810.0	11,620.0	2,510.0	2,510.0	5,020.0	1,200.0	1,050.0	1,050.0	1,200.0	4,500.0
Superimposed load	2,640.0	2,640.0	5,280.0	1,140.0	1,140.0	2,280.0	550.0	450.0	450.0	550.0	2,000.0
Dead Load all	8,450.0	8,450.0	16,900.0	3,650.0	3,650.0	7,300.0	1,750.0	1,500.0	1,500.0	1,750.0	6,500.0
Live Load (Max)	3,500.0	3,500.0	-	2,000.0	2,000.0	-	850.0	950.0	950.0	850.0	-
Live Load (Min)	-500.0	-500.0	-	-300.0	-300.0	-	600.0	700.0	700.0	600.0	-
Dead + Live (Max)	11,950.0	11,950.0	-	5,650.0	5,650.0	-	2,600.0	2,450.0	2,450.0	2,600.0	-
Dead + Live (Min)	7,950.0	7,950.0	-	3,350.0	3,350.0	-	2,350.0	2,200.0	2,200.0	2,350.0	-

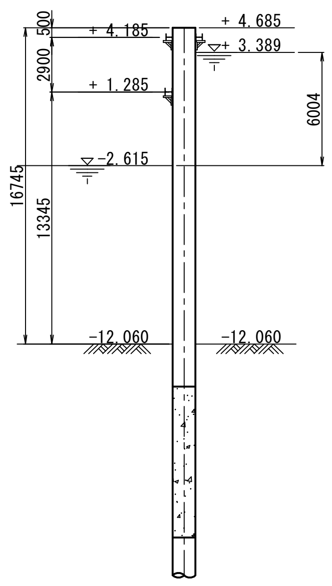
INSTALLATION PROCEDURE OF TEMPORARY SUPPORTS IN SPSP

Sample

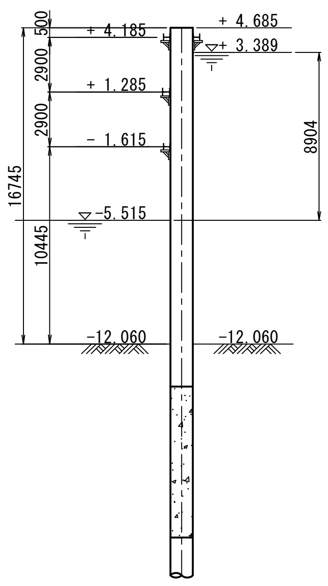
STEP 1



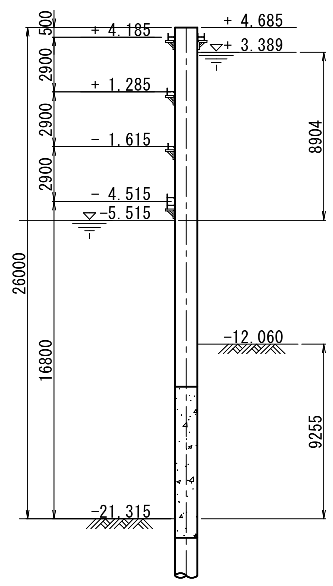
STEP 2



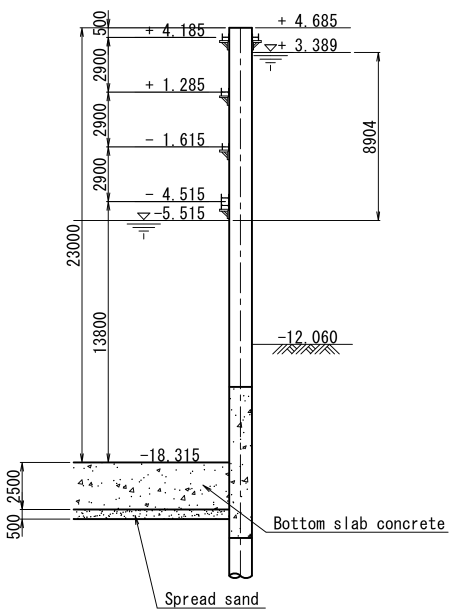
STEP 3



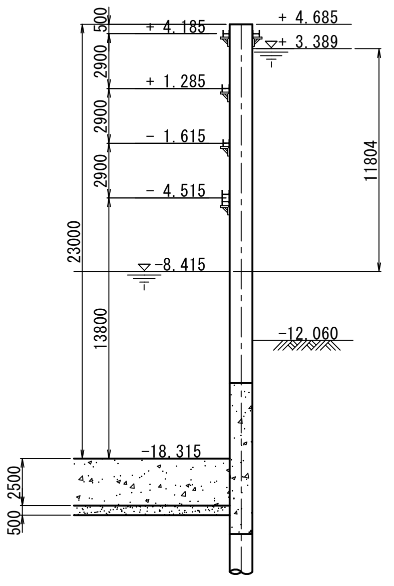
STEP 4



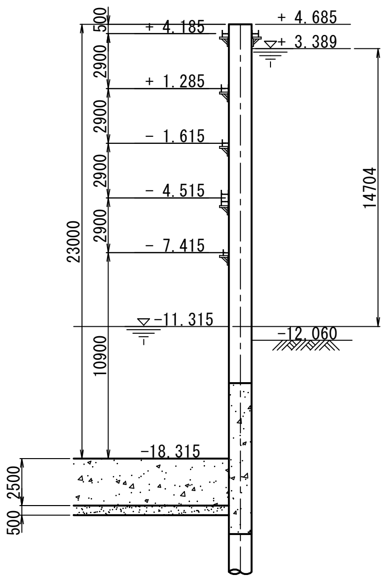
STEP 5



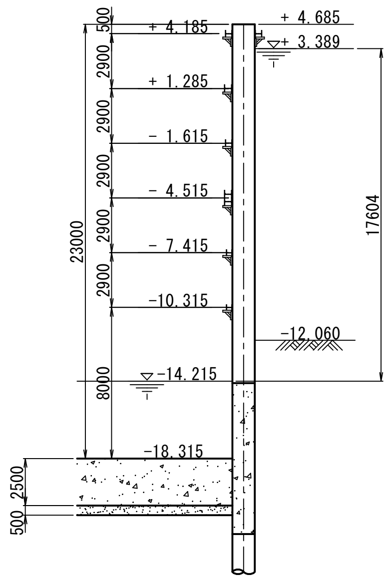
STEP 6



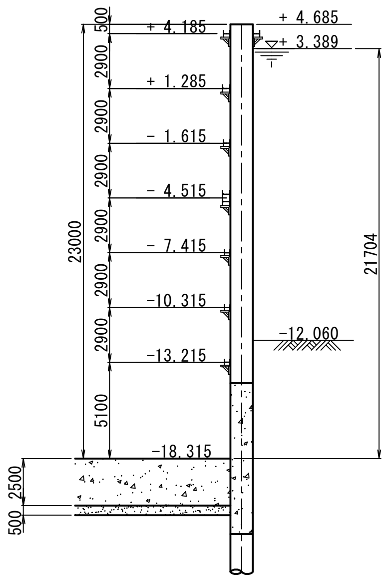
STEP 7



STEP 8



STEP 9



Appendix B Examinations

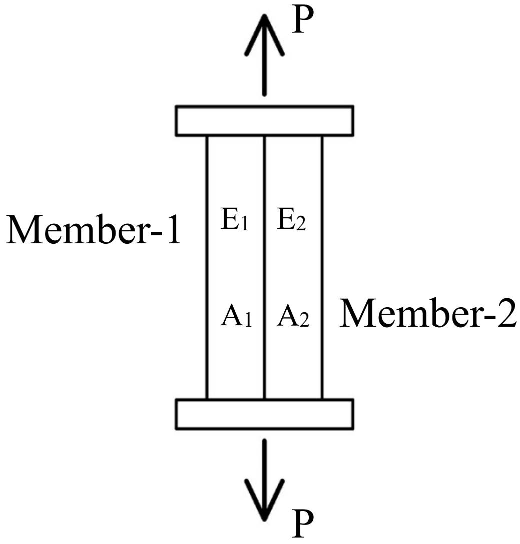
B-1 Pre-test of Special Lecture

Pre-Test (19th Oct. 2017)
Lecture : Special Lecture for Cable Stayed Bridge

Name :	Score :

Question 1.

Calculate the force at each member: P_1 and P_2

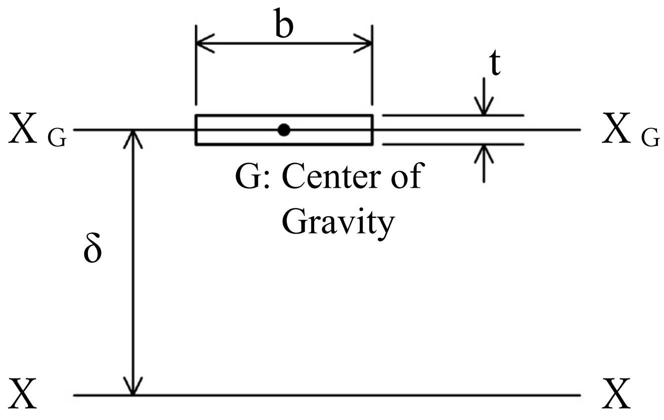


E_i: Young’s Modulus of Elasticity
A_i: Cross Sectional Area

P_1: Force at Member-1 (E_1, A_1)
P_2: Force at Member-2 (E_2, A_2)

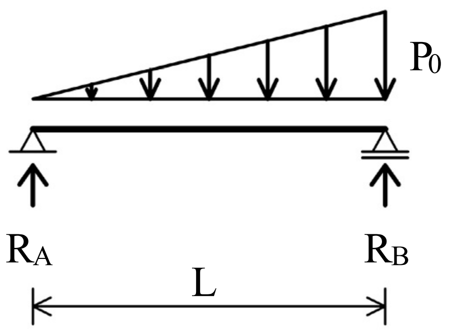
Question 2.

Calculate second moment of inertia about the X_G axis [I_{XG}] and X axis [I_X].



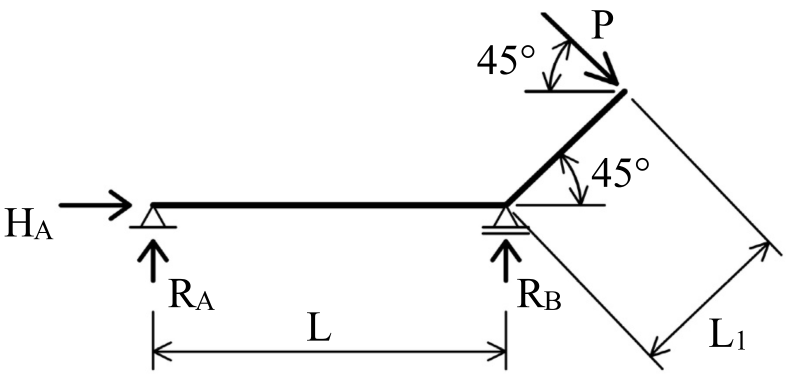
Question 3.

Calculate reaction force of R_A, R_B and H_A.



Question 4.

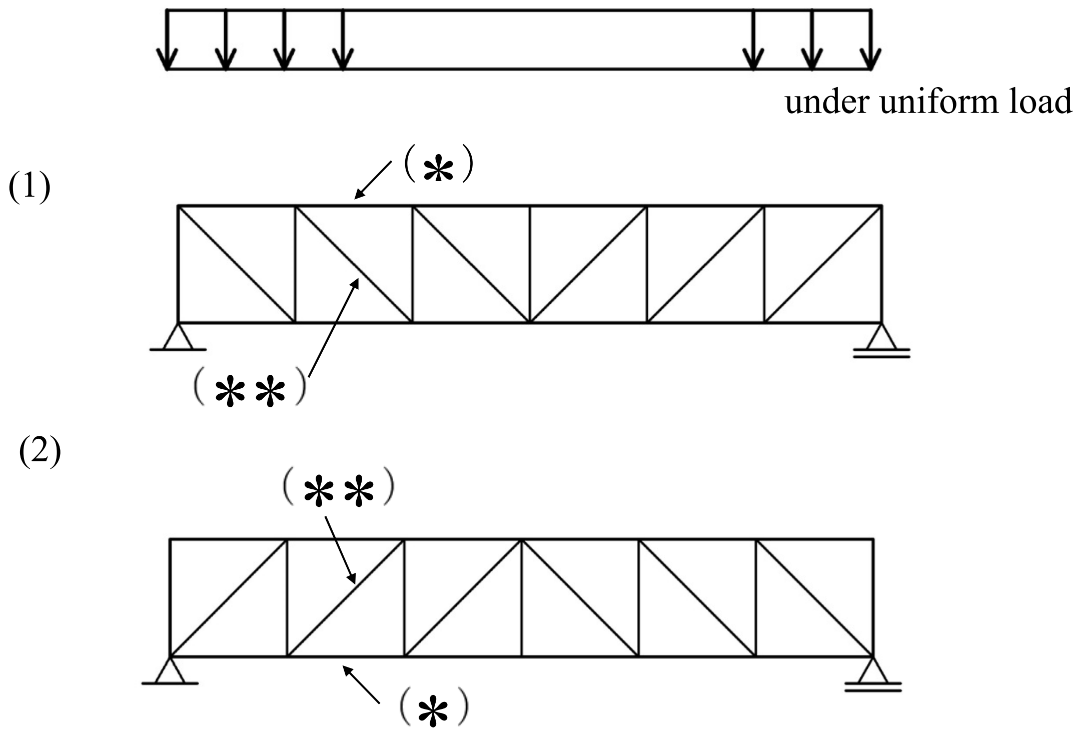
Calculate reaction force of R_A, R_B and H_A.



$\sin 45° = \cos 45° = 1/\sqrt{2}$

Question 5.

Identify the members (*, **) are subjected to tension or compression.



Appendix B Examinations

B-2 Pre-test of Superstructure Design (Concrete)

Pre-Test

Lecture : Superstructure Design-1 (Concrete)

Name :	Score :

Question 1. Type of Bridges

Select the correct combination of bridge types from the following options A ~ E:

		
(1)	(2)	(3)

A. (1) Frame bridge (2) Girder bridge (3) Arch bridge
B. (1) Frame bridge (2) Arch bridge (3) Girder bridge
C. (1) Girder bridge (2) Frame bridge (3) Arch bridge
D. (1) Girder bridge (2) Arch bridge (3) Frame bridge
E. (1) Arch bridge (2) Frame bridge (3) Girder bridge

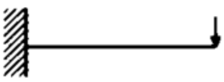
Question 2. Basic of Statics

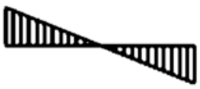
A concentrated load is acting on the tip of a cantilever beam as shown in the right figure below.

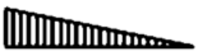
Q2-1. Choose the correct bending moment diagram from A ~ D. A2-1

Q2-2. Choose the shear force diagram from A ~ D. A2-2

A. 



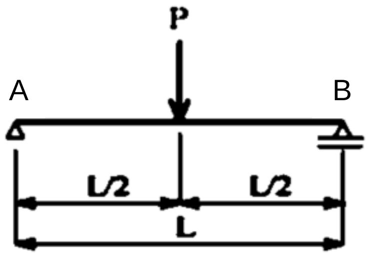
B. 

C. 

D. 

Question 3. Basic of Statics

A concentrated load P is acting at the center of a simply supported beam of length L.



Q3-1. Calculate the support reactions at A (left) and B (right).

Reaction at support A: ___________

Reaction at support B: ___________

Q3-2. Draw the bending moment diagram.

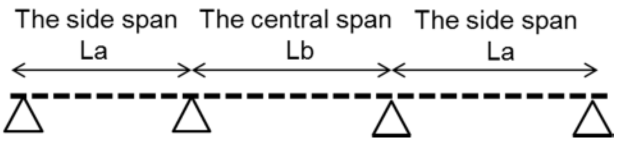
A _________________________________ B

Q3-3. Calculate the maximum bending moment.

Mmax = _____________________

Question 4. Consideration on Span Arrangement

Select the correct combination of span length ratio which is statically most ideal for three-span continuous girder among the following options (construction condition & erection method are ignored).



A. La : Lb = 1.0 : 1.0
B. La : Lb = 1.0 : 1.2
C. La : Lb = 1.0 : 1.25
D. La : Lb = 1.0 : 1.3
E. La : Lb = 1.0 : 1.5

Question 5. Erection Method of Concrete Girder Bridges

Select the name of erection method for concrete girder bridges from the options A ~ E which is described in the following.

[Erection method]

A Concrete girder is constructed symmetrically from pier tables block by block using form travelers.

A. Span-by-span erection method
B. Free Cantilever erection method
C. Incremental launching method
D. Crane erection method
E. Erection beam method

Question 6. Creep and Shrinkage of Concrete

Select the most appropriate description about creep and shrinkage of concrete from the followings.

A. Creep deformation is assumed to be proportional to the elastic displacement.

B. Deformation due to creep is finished in about one month.

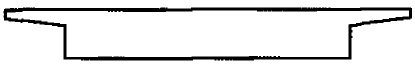
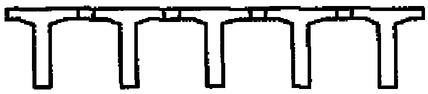
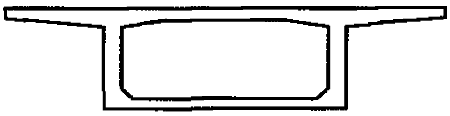
C. Creep is caused only by self-weight.

D. Creep is a phenomenon to steel

E. Shrinkage strain is increased gradually after casting of concrete.

Question 7. Type of Girder Cross Section

Select the correct combination of cross sections of concrete girder bridge arranged in the order of practically applicable span lengths from longer to shorter.

 (1) Solid slab	 (2) T-girder
 (3) Box girder	 (4) Hollow slab

A. (1) – (2) – (3) – (4)

B. (1) – (4) – (2) – (3)

C. (2) – (3) – (1) – (4)

D. (3) – (4) – (2) – (1)

E. (3) – (2) – (4) – (1)

Question 8. Concrete bridges using precast elements

Describe advantages and disadvantages of applying precast elements to concrete bridges, compared to cast-in-place construction.

Appendix B Examinations

B-3 Pre-test of Substructure Design

Pre-Test
Lecture : Substructure Design

Name :	Score :

Question 1. [score 10]

Please select the suitable type of foundation under the conditions below from A. to D.

Conditions:

- There is gravel, size range from Dia.100 to Dia.150mm, in the middle layer.
- Bearing layer, soft rock, exists in 35m from ground surface.
- Extremely large amount of inflow water.
- Water depth is 1.5m.

A. Cast-in-Placed RC Pile Foundation by All Casing Method
B. Deep Foundation
C. Pneumatic Caisson Foundation
D. Diaphragm Wall Foundation

Answer:______________________

Question 2. [score 10]

Please select the most suitable type of foundation from A. to D. under the conditions below.

Conditions:

- Bearing layer, sand with N-value 50, exists over 60m depth from ground surface.
- There is high possibility that the position of the support layer is not same depth.
- Water depth is 3.0m.
- Vibration and noise control are required.

A. Steel Pipe Pile by percussion driving method
B. Steel Pipe Pile by vibratory hammer method
C. Rotation Steel Pile Method
D. SPSP

Answer:______________________

Question 3. [score 10]

Why Cast-in-placed RC Pile by All Casing Method is not applicable under the conditions that very soft layer in the middle layer or the vicinity of surface layer exist?

Answer:

Table: Referential Criteria of Applicability of Foundation Type

applied condition \ foundation type				spread foundation	Pile Foundation															Deep foundation		caisson foundation		steel pile sheet pile foundation	diaphragm wall foundation
					driving pile method			pile boring method						steel pipe pile soil cement piles	preboring method	cast-in-place piles method			Rotation Pile method						
						steel pipe piles		PHC piles ・ SC piles			steel pipe piles														
					PHC piles ・SC piles	percussion method	vibratory hammer method	final driving method	jetting and mixing method	concrete placement method	final driving method	jetting and mixing method	concrete placement method			all casing method	reverse circulation drill method	earth drill method		set pile deep foundation	column ar deep foundation	pneumatic	open		
ground condition	condition until bearing layer	There is a very soft layer in the middle layer or the vicinity of the surface layer			○	○	○	○	○	○	○	○	○	○	○	×	○	○	○	×	×	○	△	○	○
		There is a very hard layer in the intermediate layer			△	△	△	○	○	○	○	○	○	○	○	△	○	×	○	○	○	○	△	△	○
		There is gravel in the middle layer	gravel diameter less than or equal to 50mm		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			gravel diameter 50～100mm		△	△	△	△	△	△	△	△	△	○	○	△	×	○	○	○	○	○	○	△	△
			gravel diameter 100～150mm		×	×	×	×	×	×	×	×	×	×	×	△	×	×	×	○	○	○	△	×	△
		There is a ground to liquefaction			○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			○	○	○	○
	bearing layer condition	depth	less than 5m	○	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	○		×	×	×	×
			5～15m	△	○	○	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	○	○	△	△
			15～25m	×	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			25～40m	×	○	○	○	○	○	○	○	○	○	○	○	○	○	△	○	△	△	○	○	○	○
			40～60m	×	△	○	○	△	△	△	○	○	○	○	○	△	○	×	○	×	×	△	○	○	○
			over 60m	×	×	△	△	×	×	×	×	×	×	△	△	×	△	×	○	×	×	×	△	△	△
		soil	sand ・ sand gravel (30≦N)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			cohesive soil (20≦N)	○	○	○	○	○	△	×	○	△	×	△	△	○	○	○	△	○	○	△	△	○	○
			soft rock ・ hardpan	○	×	○	△	○	△	×	○	△	×	△	△	○	○	○	△	○	○	○	○	○	○
			hard rock	○	×	×	×	×	×	×	×	×	×	×	×	△	△	△	×	○	○	△	×	×	△
		There is high possibility that the position of the support layer is not same depth, including; slope is large, irregularities of surface layer is heavy, etc.,		△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	△	×	○	○
	groundwater condition	Groundwater level is near the ground surface		△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	○	△	△	○	○	○	△
		extremely large amount of inflow water		△	○	○	○	○	○	○	○	○	○	△	△	△	△	△	○	×	×	○	○	○	△
		there is artesian water that 2m deeper than the surface		×	○	○	○	×	×	×	×	×	×	×	×	×	×	×	○	×	×	△	△	○	×
		groundwater flow rate over 3m/min		×	○	○	○	○	×	×	○	×	×	×	×	×	×	×	○	×	×	○	△	○	×
type of support		bearing pile			○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○					
		friction pile			○	○	○	×	×	×	×	×	×	○	×	○	○	○	×						
construction condition	aquatic construction	water depth less than 5m		△	○	○	○	△	△	△	△	△	△	×	×	×	×	×	○			△	△	○	×
		water depth over 5m		×	△	○	○	△	△	△	△	△	△	×	×	×	×	×	○			△	△	○	×
	narrowness of work space			○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	○	△	△	×	△
	construction of batter pile				○	○	○	×	×	×	×	×	×	×	×	×	×	×	○	×					
	effect of toxic gas				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	×	×	×	○	○	○
	surrounding environment	vibration and noise control		○	×	×	△	△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	×	○
		Effects on adjacent structures		○	×	△	△	△	○	○	△	○	○	○	○	○	○	○	○	△	△	△	△	△	○

Applicability O: high △: moderate X: low

Question 4. [score 10]

Does the following layer have a possibility to occur liquefaction?

- The groundwater level is in less than 5m from earth surface, and the saturation soil layer exists in a range from surface to 15m depth.
- D50 [50% particle diameter] is 7 mm and D10 [10% particle diameter] is 1 mm.
- Plasticity index (IP) is less than 12 and fine-grain fraction content (FC) is 38%.

A. Yes, it has possibility. So, further evaluation (calculation of F_L (resistivity to liquefaction)) is necessary for judgement.

B. No, it does not have possibility.

Answer:______________________

Question 5. [score 8 x 5 questions]

Does the Clayey Sand layer in 16m depth have a possibility to occur liquefaction? Please assess that layer based on the laboratory test result for sampling No.P14.

Question 5.1 Please read D50 [50% particle diameter] in the Grain Size Distribution Curve.

Answer:______________________

Question 5.2 Please read D10 [10% particle diameter] in the Grain Size Distribution Curve.

Answer:______________________

Question 5.3 Please read FC [fine-grain fraction content] in the Grain Size Distribution Curve.

**FC is the fraction of fine grains (<0.075mm) contained in the ground material (<75mm).*

Answer:______________________

Question 5.4 Please calculate IP (Plasticity index) from Atterberg's Limit Test Result.

Answer:______________________

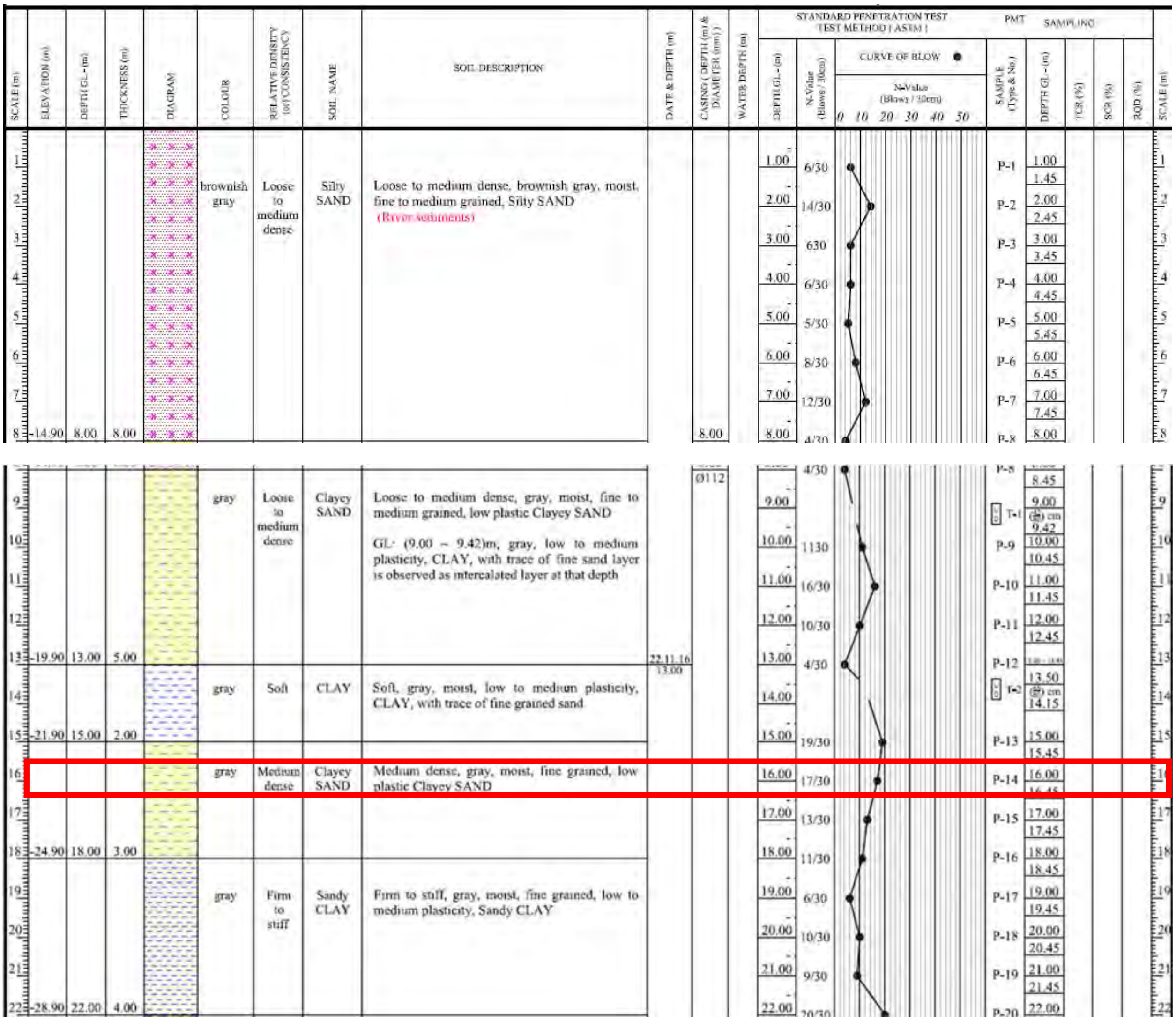
Question 5.5 Does this soil layer have a possibility to occur liquefaction?

A. Yes, it has possibility. So, further evaluation (calculation of F_L (resistivity to liquefaction)) is necessary for judgement.

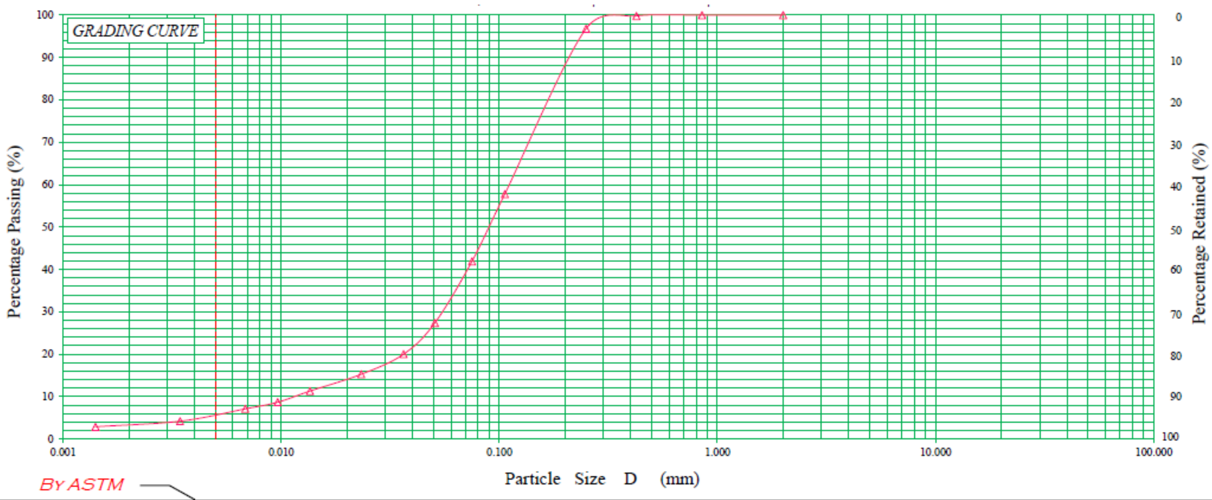
B. No, it does not have possibility.

Answer:______________________

Boring Log (Bore Hole No.BH-BD-05 in the river, ground level EL-6.90m)



Particle Size Analysis Test (Grain Size Distribution Curve of Sample No.P-14)

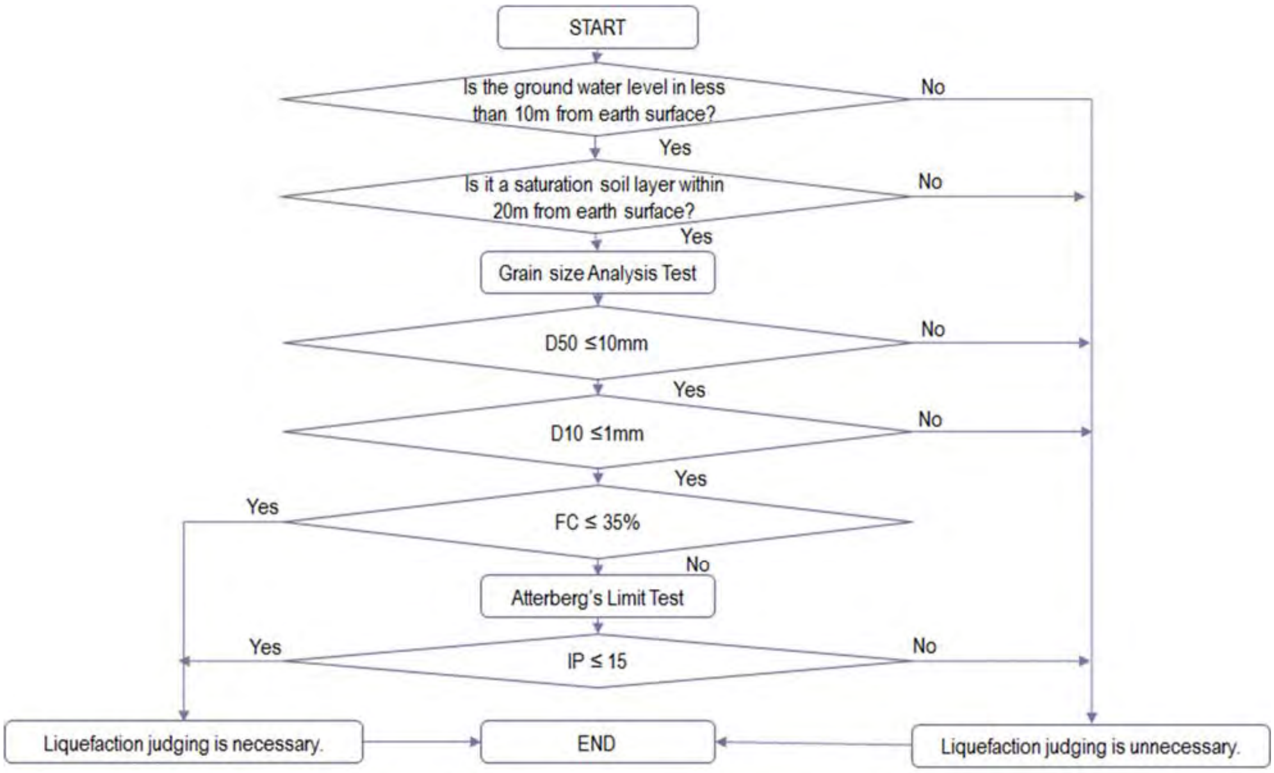


Colloids	Fines (Clay)	Fines (Silt)	Fine Sand	Medium Sand	Coarse Sand	Fine Gravel	Coarse Gravel	Cobble
	0.005	0.075	0.425	2.0	4.75	19.00	75.00	

Remarks: Gravel(%)= -	Silt(%) = 36.25	TEST BY:	E E W, M E P
Sand(%) = 58.05	Clay(%) = 5.70	CHECK BY:	T H

Laboratory Test Result (Atterberg's Limit)

Sample No.				P-11	P-12	T-2	P-13	P-14
Depth (m)				12.00 ~ 12.45	13.00 ~ 13.45	13.50 ~ 14.15	15.00 ~ 15.45	16.00 ~ 16.45
Moisture Content		w	%	22.57	33.18	34.98	27.56	28.25
Bulk Density		ρ_t	g/cm^3	-	-	1.726	-	-
				-	-	1.734	-	-
Atterberg's Limit	Liquid Limit	WL	%	-	51.70	36.40	17.65	23.11
	Plastic Limit	WP	%	-	21.83	21.83	14.15	18.42

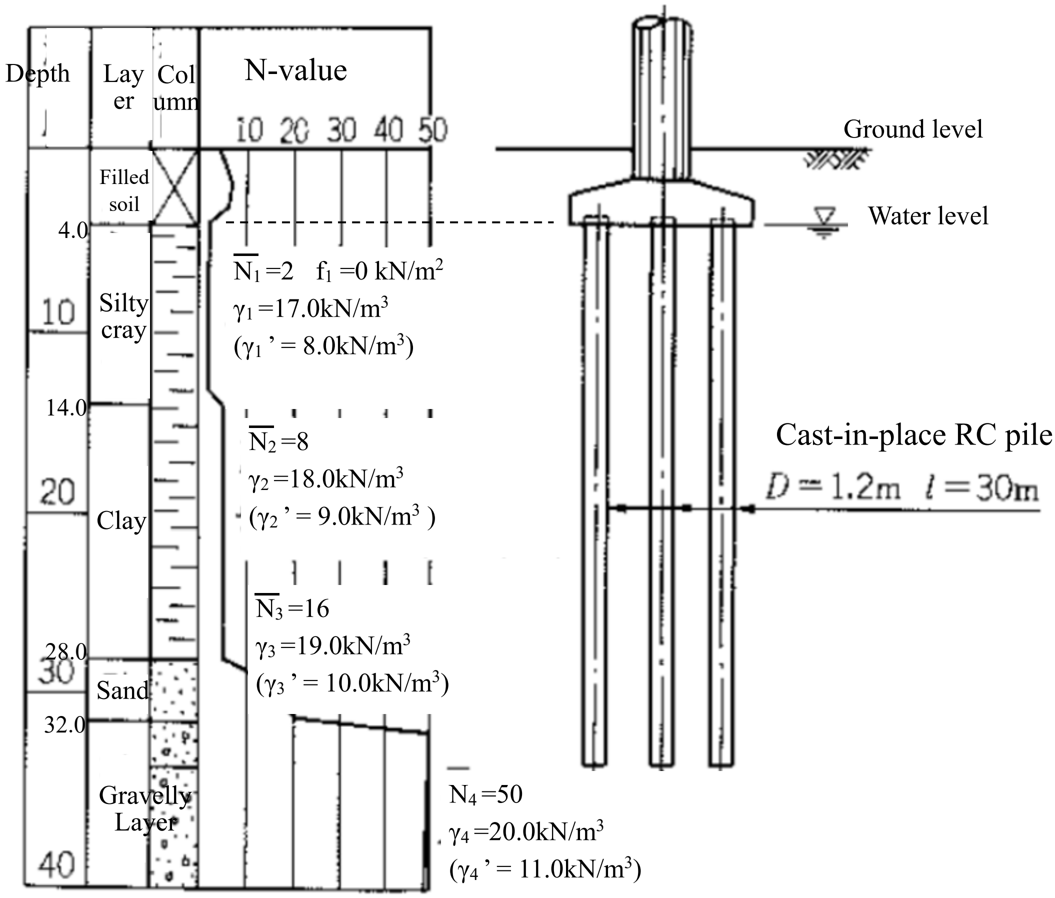


Flow Chart of Initial Assessment of Potential of Liquefaction

Question 6. [score 10 x 2 questions]

Calculation of Ultimate Bearing Capacity and Pull-Out Capacity of single CIP RC Pile with Diameter 1.2m and length 30m.

Geological Condition



Note)
The shaft resistance intensity for soft clay layer with small N value needs to to be estimated by appropriate soil tests. Here, the value of f_1 for silty clay layer is to be calculated as 0 kN/m² due to un-reliability.

Type of foundation

- Cast-in-place RC pile
- Pile diameter: D=1.2m
- Pile length: L=30.0m
- Unit weight of RC concrete: 24.5kN/m³

Question 6.1 Calculate Ultimate Bearing Capacity of Pile (Ru) (kN)

$$Ru = qd \cdot Ap + U \cdot \Sigma(Li \cdot fi)$$

qd：ultimate end bearing capacity intensity per unit area (kN/m^2)

Table: qd for Cast-in place RC pile:

Ground Type	Ultimate Bearing Capacity End Bearing Intensity (kN/m^2)
Gravelly Layer and Sandy Layer ($N \geq 30$)	3,000
Sturdy Gravelly Layer ($N \geq 50$)	5,000
Hard Cohesive Soil Layer	$3q_u$

Notes) q_u : unconfined compressive strength (kN/m^2),
N : N value from the Standard Penetration Test (SPT)

(Source: JSHB)

Ap：area of pile tip (m^2)
U ：perimeter of pile (m)
Li：thickness of soil layer considering shaft resistance(m)
fi：maximum shaft resistance of soil layer considering pile shaft resistance (kN/m^2)

It is noted that shaft friction is not considered in the range of 1.0・D from the tip of pile for calculation of ultimate bearing capacity.

Table: maximum shaft resistance depending on pile installation method and soil type

Ground Type / Pile Installation Method	Sandy Soil	Cohesive Soil
Driven Pile Method (including Vibro-hammer Method)	$2N$ (≤ 100)	c or $10N$ (≤ 150)
Cast-in-place RC Pile Method	$5N$ (≤ 200)	c or $10N$ (≤ 150)
Bored Pile Method	$2N$ (≤ 100)	$0.8c$ or $8N$ (≤ 100)
Pre bored Pile Method	$5N$ (≤ 150)	c or $10N$ (≤ 100)
Steel Pipe Soil Cement Pile Method	$10N$ (≤ 200)	c or $10N$ (≤ 200)

(Note) c: cohesion of ground (kN/m^2), N: N value from SPT.

i	Depth (m)	Thickness *li* (m)	Soil type	Averaged N-value	Shaft resistance intensity f_i (kN/m^2)	$l_i \cdot f_i$ (kN/m)
1	4.0-14.0	10.0	Silty clay	2	0	0
2	14.0-28.0	14.0	Clay			
3	28.0-32.0	4.0	Sand			
4	32.0-33.0	1.0	Gravel			
4	33.0-34.0	1.0	Gravel			
Total		30.0	-	-	-	

Answer:________________________

Question 6.2 Calculate Ultimate Pull-Out Capacity Pu (kN)

$$Pu = U \times \Sigma li \times fi$$

Answer:______________________

Appendix B Examinations

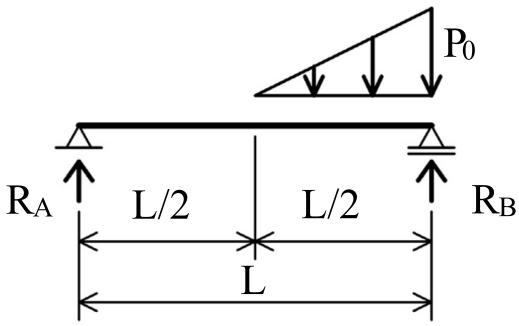
B-4 Examination of Special Lecture

Examination (20^{th} Dec. 2017) 09:30~11:30 (2h)
Lecture: Special Lecture

Name:	Score:

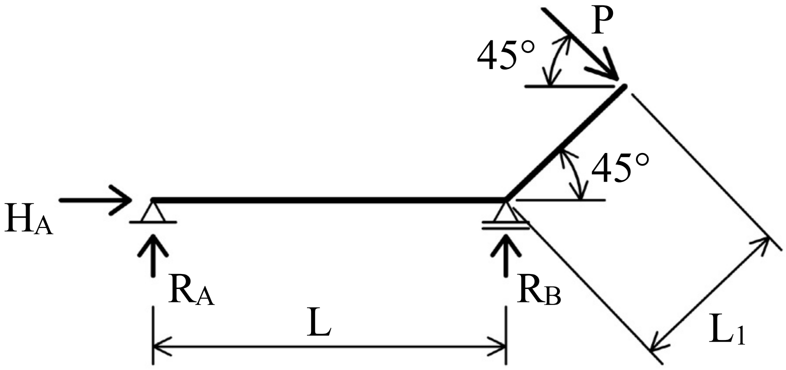
Question 1.

Calculate reaction force of R_A, R_B.



Question 2.

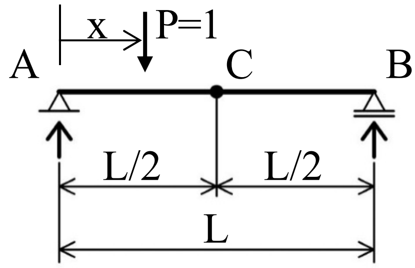
Calculate reaction force of R_A, R_B and H_A.



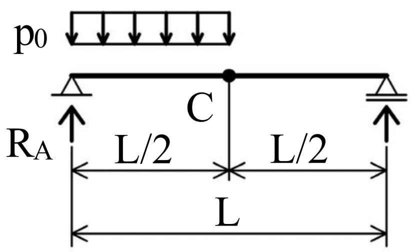
$\sin 45° = \cos 45° = 1/\sqrt{2}$

Question 3.

(1) Draw Influence line of Reaction at A, B (Ra, Rb), Moment at C (Mc) and Shear Force at C (Qc)

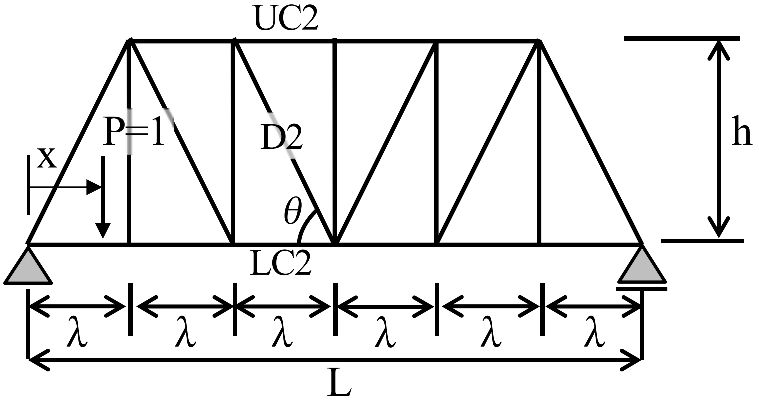


(2) Calculate Reaction Ra and Moment at C using Influence line.



Question 4.

Draw <u>Influence Line</u> of member force at upper chord (UC2), diagonal member (D2) and lower chord (LC2).

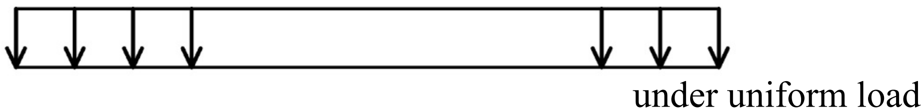


sin θ = s

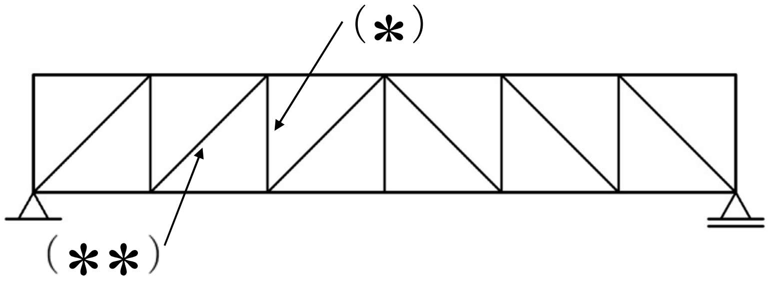
cos θ = c

Question 5.

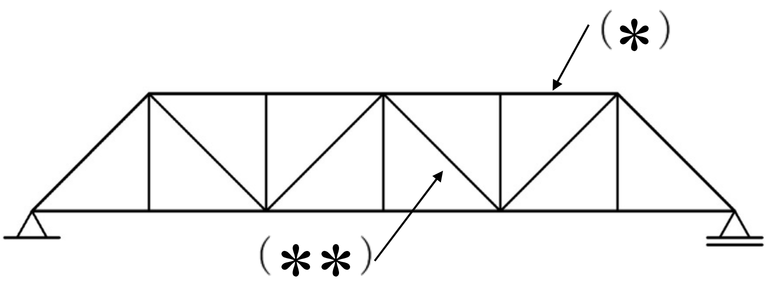
Identify the members (*, **) are subjected to <u>tension or compression</u>.



(1)

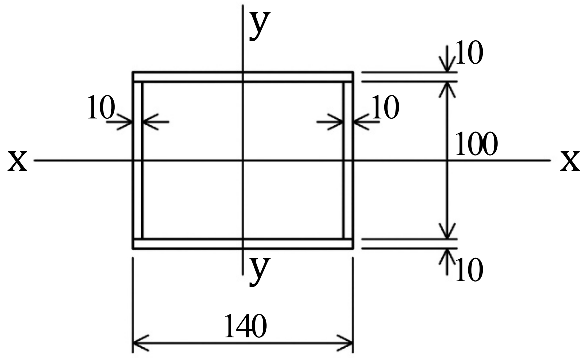


(2)



Question 6.

(1) Calculate Area (A), Second Moment of Inertia at x-axis (Ix) and y-axis (Iy).



(mm)

(2) Calculate allowable buckling stress of column by JSHB. (Equations: Refer next page)

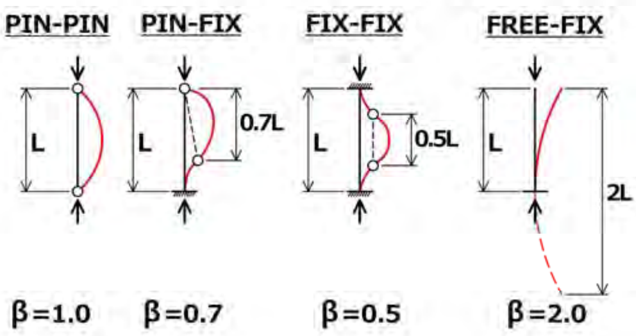
- Cross Section: Same with the section at (1) - Length of Column L=5000mm
- Support Condition of Column: Fix-Fix - Material: SM400

Allowable Buckling Stress of Column

Plate thickness (mm) \ Steel type	SS400 SM400 SMA400W	SM490	SM490Y SM520 SMA490W	SM570 SMA570W
40 or less	$140: \frac{l}{r} \leqq 18$ $140-0.82\left(\frac{l}{r}-18\right): 18<\frac{l}{r}\leqq 92$ $\frac{1,200,000}{6,700+\left(\frac{l}{r}\right)^2}: 92<\frac{l}{r}$	$185: \frac{l}{r} \leqq 16$ $185-1.2\left(\frac{l}{r}-16\right): 16<\frac{l}{r}\leqq 79$ $\frac{1,200,000}{5,000+\left(\frac{l}{r}\right)^2}: 79<\frac{l}{r}$	$210: \frac{l}{r} \leqq 15$ $210-1.5\left(\frac{l}{r}-15\right): 15<\frac{l}{r}\leqq 75$ $\frac{1,200,000}{4,400+\left(\frac{l}{r}\right)^2}: 75<\frac{l}{r}$	$255: \frac{l}{r} \leqq 18$ $255-2.1\left(\frac{l}{r}-18\right): 18<\frac{l}{r}\leqq 67$ $\frac{1,200,000}{3,500+\left(\frac{l}{r}\right)^2}: 67<\frac{l}{r}$
More than 40 and up to 75	$125: \frac{l}{r} \leqq 19$ $125-0.68\left(\frac{l}{r}-19\right): 19<\frac{l}{r}\leqq 96$ $\frac{1,200,000}{7,300+\left(\frac{l}{r}\right)^2}: 96<\frac{l}{r}$	$175: \frac{l}{r} \leqq 16$ $175-1.1\left(\frac{l}{r}-16\right): 16<\frac{l}{r}\leqq 82$ $\frac{1,200,000}{5,300+\left(\frac{l}{r}\right)^2}: 82<\frac{l}{r}$	$195: \frac{l}{r} \leqq 15$ $195-1.3\left(\frac{l}{r}-15\right): 15<\frac{l}{r}\leqq 77$ $\frac{1,200,000}{4,700+\left(\frac{l}{r}\right)^2}: 77<\frac{l}{r}$	$245: \frac{l}{r} \leqq 17$ $245-2.0\left(\frac{l}{r}-17\right): 17<\frac{l}{r}\leqq 69$ $\frac{1,200,000}{3,600+\left(\frac{l}{r}\right)^2}: 69<\frac{l}{r}$
More than 75 and up to 100			$190: \frac{l}{r} \leqq 16$ $190-1.3\left(\frac{l}{r}-16\right): 16<\frac{l}{r}\leqq 78$ $\frac{1,200,000}{4,800+\left(\frac{l}{r}\right)^2}: 78<\frac{l}{r}$	$240: \frac{l}{r} \leqq 17$ $240-1.9\left(\frac{l}{r}-17\right): 17<\frac{l}{r}\leqq 69$ $\frac{1,200,000}{3,700+\left(\frac{l}{r}\right)^2}: 69<\frac{l}{r}$
Remarks	l : Effective buckling length of member (mm) r : Radius of gyration of gross section area of member (mm)			

Le : Effective buckling length

β : Buckling coefficient （Le = β L）



Radius of gyration: r

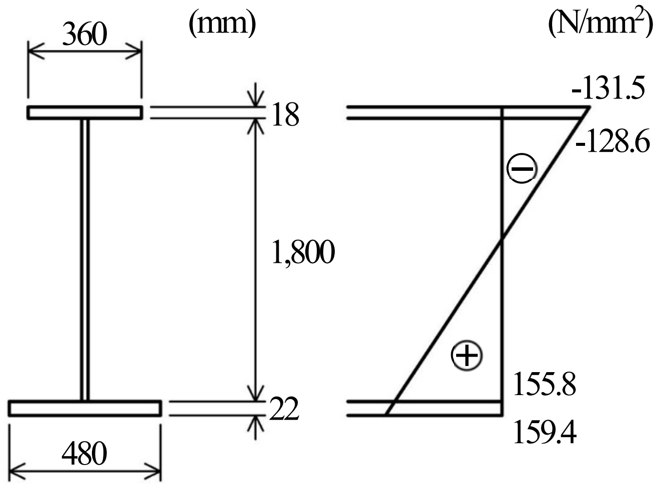
$$r = \sqrt{\frac{I}{A}}$$

I: Second Moment of Inertia

A: Area of Cross Section

Question 7.

Calculate <u>required number of friction bolts</u> at upper flange and lower flange.



[Design Conditions]

- Bolt: M22, F10T
- 2-plane friction
- Material Grade: SM490Y

($\sigma a = 210$ N/mm²)

[Calculation]

(1) Design Stress (σ_o)

$\sigma_o = \max.\{\sigma_n, 0.75\sigma_{ca}\}$

σ_{ca} : allowable compressive/tensile stress

(2) Number of bolt ($n_{req.}$)

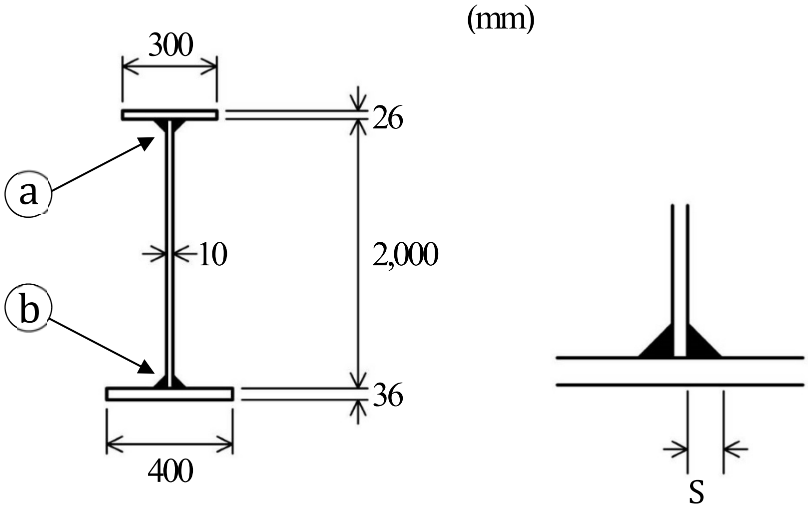
$n_{req.} > \dfrac{\sigma_o A_f}{\rho_a}$ A_f : Area of Flange

Allowable bolt force (ρ_a)

bolt grade	nominal designation of thread	γ	μ	α	σ_y (N/mm²)	A_e (mm²)	N (kN)	ρ_a (kN)
F8T	M20 M22 M24	1.7	0.4	0.85	640	245 303 353	133 165 192	31 39 45
F10T S10T	M20 M22 M24	1.7	0.4	0.75	900	245 303 353	165 205 238	39 48 56

Question 8.

Calculate <u>fillet welding size (s)</u> at a and b.



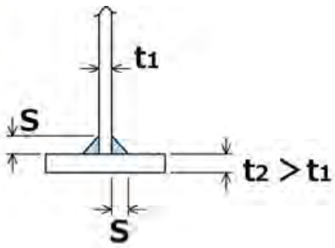
1）Size of fillet welding

$$t_1 > S > \sqrt{2t_2}$$

t_1 : thinner plate thickness

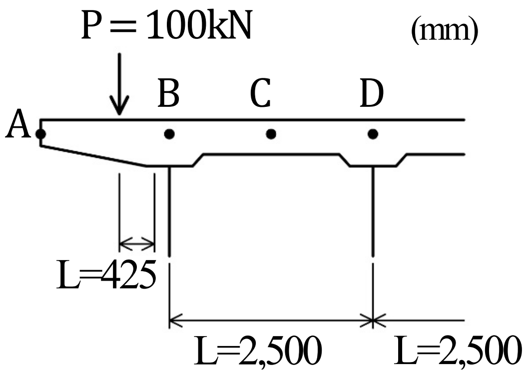
t_2 : thicker plate thickness

($S_{min.} > 6mm$)



Question 9.

Calculate design moment of slab by live load in main direction and distributing direction at A, B, C and D.



Design moment per unit length (1m) by T-load for RC slab

(kN·m/m)

		simple slab (0 < L ≦ 4m)	continuous slab (0 < L ≦ 4m)			cantilevered slab (0 < L ≦ 1.5m)	
		at span center	at span center	at span center (end span)	at intermediate support	at support	at tip
dead load(*) (w)		$\frac{wL^2}{8}$	$\frac{wL^2}{14}$	$\frac{wL^2}{10}$	2-span $-\frac{wL^2}{8}$ 3-span more $-\frac{wL^2}{10}$	$-\frac{wL^2}{2}$	—
T-load	main reinforcement	(0.12L +0.07) p Ⓐ	0.8×Ⓐ	0.8×Ⓐ	−0.8×Ⓐ	$-\frac{PL}{1.30L+0.25}$	—
	distributing reinforcement	(0.10L +0.04) p Ⓑ	0.8×Ⓑ	0.8×Ⓑ	—	—	(0.15L +0.13)p

Appendix B Examinations

B-5 Examination of Superstructure Lecture (Concrete)

Examination
Lecture : Superstructure Design (Concrete)

Name :	Score :

Question 1. Erection Methods of Prestressed Concrete Bridges

Select the correct combination of erection methods by which girders can be erected without using space under bridge from the following options A ~ E:

(1) Precast girders by crane erection
(2) Precast girders by erection girders
(3) Free cantilever erection
(4) Incremental launching erection
(5) All-staging erection by conventional falsework
(6) Movable falsework erection
(7) Span-by-span erection

A. (1) – (2) – (3) – (4) – (5)
B. (1) – (3) – (4) – (5) – (7)
C. (2) – (3) – (4) – (5) – (6)
D. (2) – (3) – (4) – (6) – (7)
E. (3) – (4) – (5) – (6) – (7)

Question 2. Bending moment diagram of PC BOX Cross Section

Select the proper diagram of bending moment generated on PC BOX Cross sections by each load case from the following figures :

(1) Self-weight (Dead Load) (1) ________ (2) ________

(2) Prestress (Due to eccentricity)

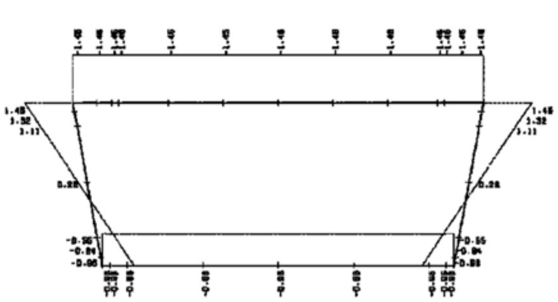
(3) Prestress (Due to eccentricity + elastic shortening) (3) ________ (4) ________

(4) Live Load (Loaded on left cantilever slab)

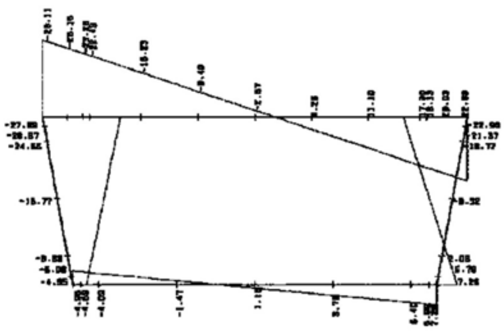
(5) Live Load (Loaded on box slab) (5) ________ (6) ________

(6) Temperature Gradient

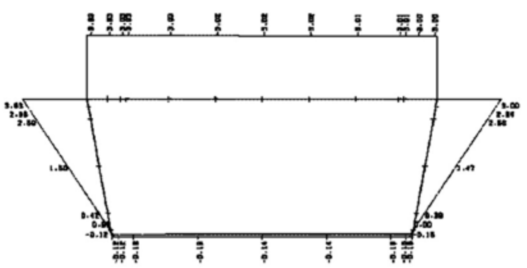
A.



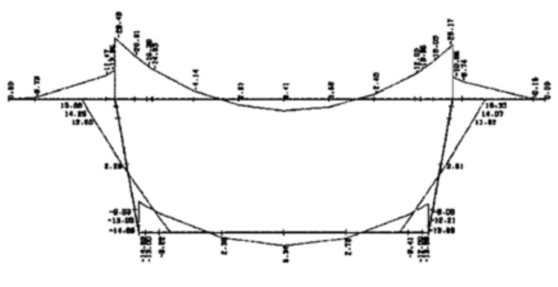
B.



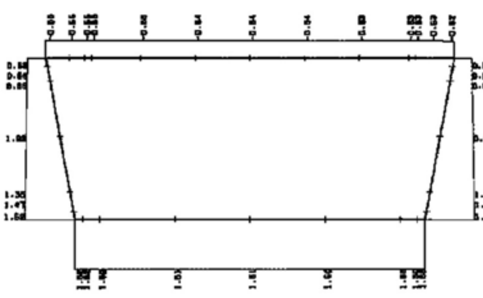
C.



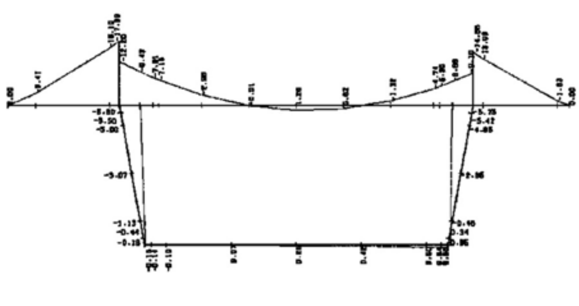
D.



E.



F.



Question 3. Concrete bridges using precast elements

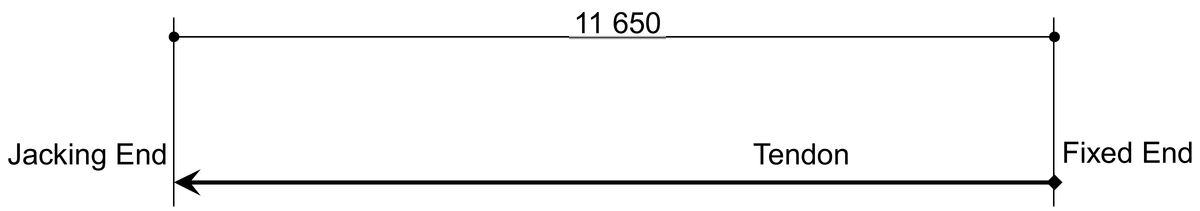
Describe advantages and disadvantages of applying precast elements to concrete bridges, compared to cast-in-place construction.

Question 4. Calculation of Prestress in deck slab (transverse prestressing)

Q3-1. Calculate the prestress immediately after anchor-set

a) Calculate the prestress after loss due to friction : $\sigma_{pt.}$ = ______________ N/mm^2

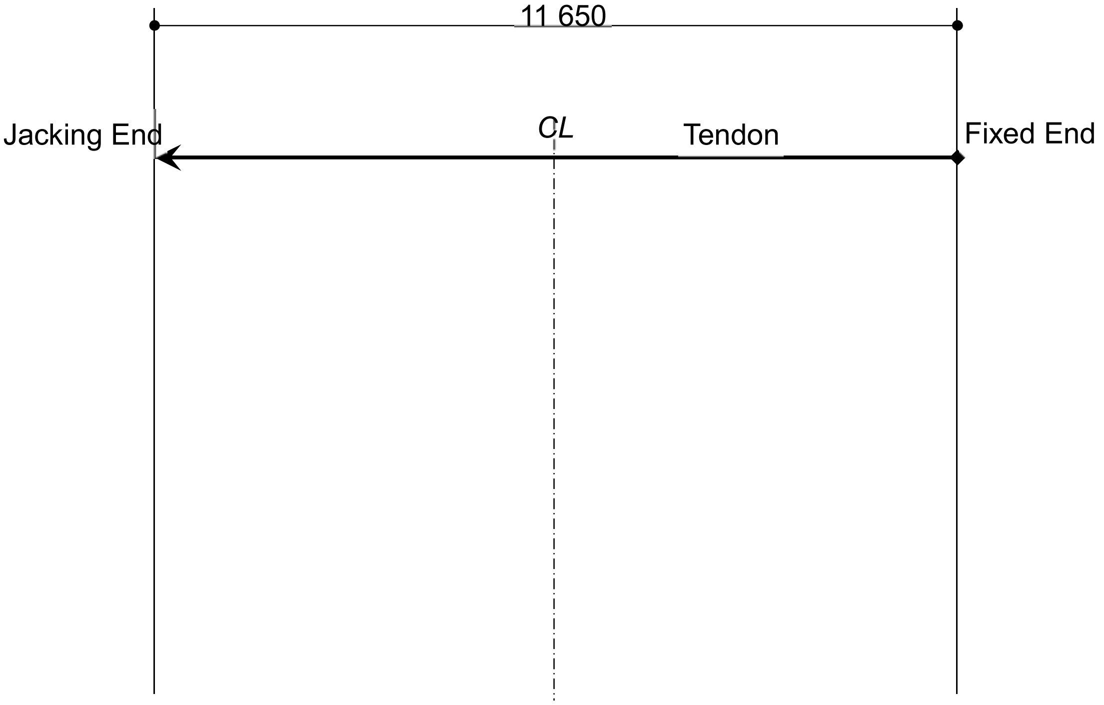
σ_{pt1}	: Tensile stress in prestressing steel at the section considered		
σ_{pt}	: Initial stress in prestressing steel at the jacking end	1 250.0	N/mm^2
λ	: Wobble friction coefficient per unit meter	0.004	/m
ℓ	: Distance from jacking end to the section considered	11.650	m
μ	: Friction coefficient due to change of angle of tendon	0.3	/rad
α	: Change of angle	0.0	rad



b) Calculate the prestress after loss due to pull-in of anchor wedges:

At fixed end :	σ_{pt2} =	______________	N/mm^2
At jacking end :	σ_{pt1}' =	______________	N/mm^2

$\Delta\sigma_{p1}$	: Loss of stress in prestressing steel due to pull-in of wedge		
ℓ	: Length of prestressing tendon	11.650	m
$\Delta\ell$	: Amount of pull-in of wedge	4.0	mm
E_p	: Modulus of elasticity of prestressing steel	2.0×10^5	N/mm^2

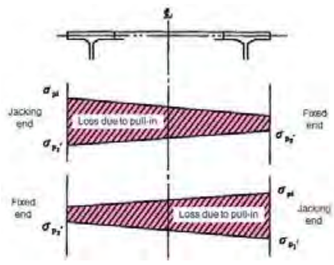


Stress diagram in prestressing steel

c) Calculate the prestress immediately after anchor-set

Elastic deformation is ignored.

Tendons are jacked at one side alternately.



σ_{p1}. = $(\sigma_{p1}' + \sigma_{pt2})$ /2 = ______________ N/mm^2

Q3-2. Calculate the effective prestress.

a) Calculate the loss of prestress due to creep and shrinkage. $\Delta\sigma_{\varphi}$ = ______________ N/mm^2

$\Delta\sigma_{\varphi}$	: Loss of stress in prestressing steel due to creep and shrinkage of concrete	
Φ	: Creep coefficient of concrete	2.6
ε_s	: Shrinkage strain of concrete	$20x10^{-5}$
n	: Modular ratio E_p / E_c	7.143
E_p	: Modulus of elasticity of prestressing steel	$2.0x10^5$ N/mm^2
E_c	: Modulus of elasticity of cpncrete	$2.8x10^4$ N/mm^2
σ_{cp}	: Stress in concrete at the centroid of tendon due to self-weight of concrete and prestress immediately after anchor-set	2.405 N/mm^2
σ_{pt}	: Stress in prestressing steel immediately after anchor-set (see Q3-1c)	
σ_{cpt}	: Stress in concrete immediately after anchor-set	2.405 N/mm^2

b) Calculate the loss of prestress due to relaxation of steel. $\Delta\sigma_{p\gamma}$ = ______________ N/mm^2

$\Delta\sigma_{p\gamma}$	: Loss of stress in prestressing steel due to relaxation	
γ	: Relaxation coefficient of prestressing steel	1.5 %
σ_{pt}	: Stress in prestressing steel Immediately after anchor-set (see Q3-1c)	

c) Calculate effective prestress in prestressing steel. σ_{pe} = ______________ N/mm^2

d) Calculate effective coefficient. $\eta = \sigma_{pe} / \sigma_{pt}$ = ______________ N/mm^2

Appendix B Examinations

B-6 Examination of Superstructure Lecture (Steel)

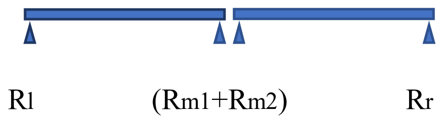
Examination
Lecture : Superstructure Design (Steel)

Name :	Score :

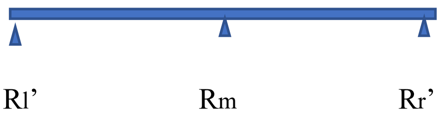
Q1 Select the proper relation between each support reactions subjected to two beam condition A and B as figured below.

Here, load and beam stiffness I is constant through the span and same for A and B.

A.



B.

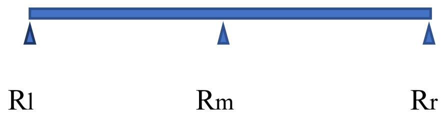


a. Rm1=R1=R1’ (Rm1+Rm2)=Rm Rm2=Rr=Rr’
b. R1＜R1’ (Rm1+Rm2)＞Rm Rr＜Rr’
c. R1＞R1’ (Rm1+Rm2)＜Rm Rr＞Rr’
d. R1＜R1’ (Rm1+Rm2)＜Rm Rr＜Rr’

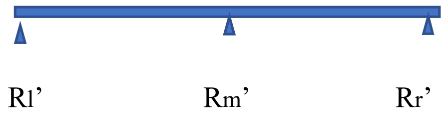
Q2 Select the proper relation between each support reactions subjected to two beam condition A and B as figured below.

Here, load is constant through the span and same for A and B. However, beam stiffness of A; Ia is larger than beam stiffness of B; Ib.

A.



B.



a.	Rl = Rl’	Rm=Rm’	Rr=Rr’
b.	Rl < Rl’	Rm>Rm’	Rr<Rr’
c.	Rl > Rl’	Rm<Rm’	Rr>Rr’
d.	Rl > Rl’	Rm>Rm’	Rr>Rr’

Q3 Select either of ○ (Correct) or ×(Wrong) about descriptions below.

a. Young's Modulus E is defined as the ratio of the elongation by its length between before/after loading.

b. Usually, Young's Modulus E is applied as $2.0x10^5(kn/m^2)$.

c. A moment of inertia for rectangular section which is a part of the combined section become larger, as the rotation axis of the whole combined section is more apart from the neutral axis of the rectangular section.

d. Polar geometrical Moment of Inertia Ip is described as $Ip=(Ix+Iy)^2$

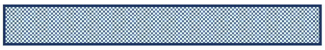
e. According to allowable stress against buckling, a bar of fulfil section is weaker than a pipe section in case that both area are same.

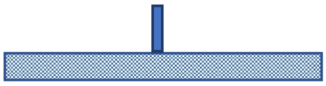
f. Euler's Buckling Phenomena is hypothesized that steel material elasticity is sustained till the steel stress comes to yield point.

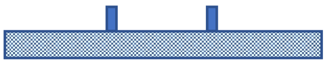
a________________ b________________ c________________

d________________ e________________ f________________

Q4 Select the proper relation of critical compression stress between section of A to C as figured below. Here, total sectional area of steel material is same in A to C.

A.  1-plate 2000x24

B.  1-plate 2000x20 1-stiffener 400x20

C.  1-plate 2000x20 2-stiffeners 200x20

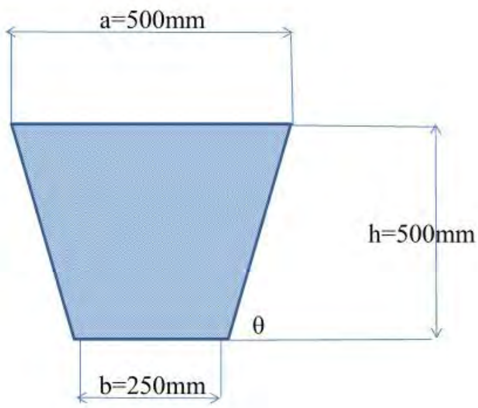
a. σ cr (A) = σ cr (B) = σ cr (C)

b. σ cr (A) < σ cr (B) = σ cr (C)

c. σ cr (A) < σ cr (B) < σ cr (C)

d. σ cr (B) < σ cr (A) < σ cr (C)

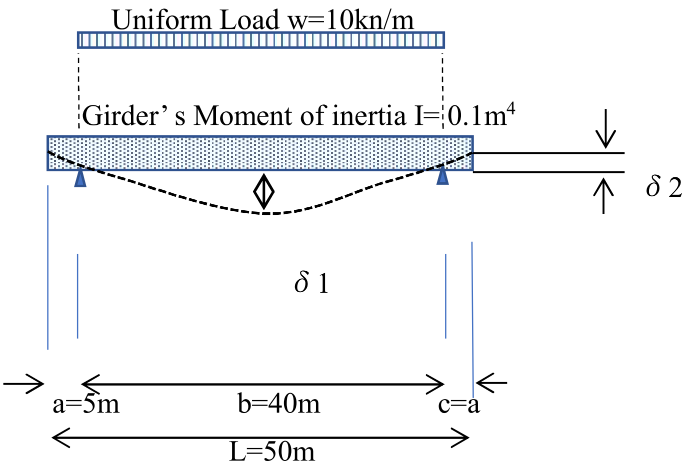
Q5 Calculate the moment of inertia ; I for trapezoidal section as figure below.



Q6 Consider a simple girder 40m length with 5m of cantilever beam at the both ends.

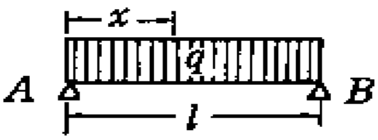
Here, calculate the deflection at the mid of span ; δ 1 and deflection at the end of cantilever ; δ 2.

Load is considered as uniform load distributed between supports only.



Supplemental explanation

Formula for bending moment; M and deflection; y of simple span beam with distributed load can be ;



$$M=\frac{ql^2}{2}\left(\frac{x}{l}-\frac{x^2}{l^2}\right)$$

$$M_{max}=\frac{ql^2}{8} \qquad y=\frac{ql^4}{24EI}\left(\frac{x}{l}-2\frac{x^3}{l^3}+\frac{x^4}{l^4}\right)$$

- Angle of deflection can be expressed as ;

  dy/dx= θ

Appendix B Examinations

B-7 Examination of Substructure Lecture

Examination
Lecture : Substructure Design

Name :	Score :

Q.1 Major verification for pile foundation

Describe the verifications to be satisfied for pile foundation design in terms of structural stability and stress verification of pile body.

A.1

Q.2 Assessment of Soil liquefaction

Describe the initial consideration for potential of liquefaction required for foundation design before calculation of FL (Liquefaction resistivity factor).

For an alluvial sandy layer having all of following three conditions, liquefaction assessment shall be judged by FL (Liquefaction resistivity factor).

1) The groundwater level is in less than _(a)__m from earth surface, and the saturation soil layer exists in the depth within _(b)_m from ground surface.

2) The soil layer whose fine-grain fraction content is less than _(c)_%, or the soil layer whose plasticity index is less than (d) even if fine-grain fraction content exceeds _(c)_%.

3) The soil layer which D(e)_ (_(e)_% particle diameter) is less than (f) mm and D(f)__((f)_ % particle diameter) is less than 1mm.

A.2

(a) ____________________ (b) ____________________ (c) ____________________

(d) ____________________ (e) ____________________ (f) ____________________

Q.3 Technical feature of Steel Pipe Sheet Pile

Describe details regarding follows for structural aspect of Steel Pipe Sheet Pile foundation.

(1) Provision of overall sectional stiffness

(2) Occurrence of residual stress on pipes

A.3

Q.4 Construction Step of Steel Pipe Sheet Pile Foundation

Arrange followings as construction steps of SPSP foundation in order of actual work flow.

a. Pier construction

b. Installation of guide piles and guide frames

c. Mortal filling in joint pipes, concrete filling in main pipes at neat top slab

d. Cutting and removal SPSP at cofferdam portion

e. Driving of steel pipe sheet piles

f. Support beam setting and dewatering inside cofferdam

g. Underwater excavation inside cofferdam

h. Temporary platform installation

i. Stud welding for pile head connection

j. Underwater concreting for bottom slab

k. Support beam setting and dewatering inside cofferdam completely

l. Casting concrete for top slab

A.4

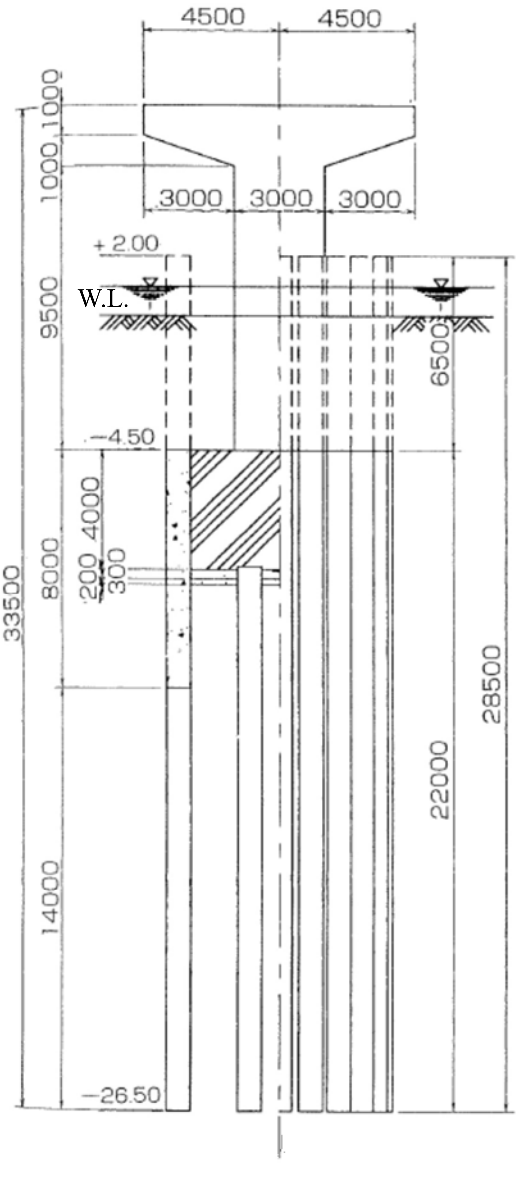
Q.5 Bearing Capacity and Pull-out Capacity of SPSP

Calculate “Allowable bearing capacity” and “Allowable pull-out capacity” of pile. Ordinary case and Seismic case shall be obtained, respectively.

Foundation Type

Steel Pipe Sheet Pile Foundation
Method: Driven pile method

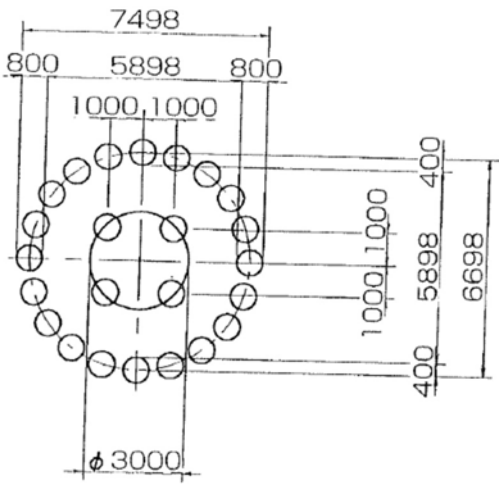
Profile Outline



Elevation	Layer	SPT value (10 20 30 40)	Thickness (m)	Average N value	Soil unit weight γ (kN/m³)	γ' (kN/m³)	Friction angle φ (°)	Cohesion c (kN/m²)
+1.00 / ±0.00 to −3.50	Sand		3.50	1	17	8	20	−
−3.50 to −9.00	Sand		5.50	11	18	9	25	−
−9.00 to −15.00	Clay		6.00	15	16	7	−	90
−15.00 to −25.50	Sand		10.50	20	18	9	32	−
−25.50 to −28.50	Sand		3.00	45	20	11	40	−

Note) For obtaining a shaft resistance intensity for clay layer, apply cohesion C shown above table.

<u>Sectional Detail</u>



- Exterior wall : 20piles

  (L=22.0m at permanent portion, L=6.5m at temporary portion)

- Inner single piles : 4piles (L=18.0m)

  Pile diameter : 800mm, Enclosed area of pile : 0.503m^2

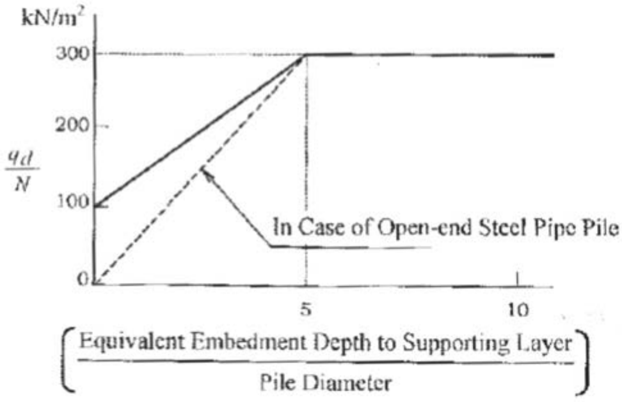
U1 : Peripheral lengths along the lines enveloping the outer periphery of the well part = 23.556m

U2 : Sum of peripheral lengths along the lines enveloping the inner peripheries = 28.582m

A: Enclosed area by well top slab = 30.2m^2

<u>Supplemental Explanation</u>

- End bearing capacity for driving pile method



- Shaft resistance for driving pile method

Pile Installation Method \ Ground Type	Sandy Soil	Cohesive Soil
Driven Pile Method (including Vibro-hammer Method)	$2N\ (\leq 100)$	c or $10\ N\ (\leq 150)$

- Allowable bearing capacity of pile

$$R_a = \frac{1}{n} R_u$$

$$R_u = q_d A_i + \frac{1}{n_1 + n_2 + n_3} \left(U_1 \Sigma L_i f_i + U_2 \Sigma L_j f_j \right)$$

- Allowable pull-out force of pile

$$P_a = \frac{1}{n} P_u + W$$

$$P_u = \frac{1}{n_1 + n_2 + n_3} \left(U_1 \Sigma L_i f_i + U_2 \Sigma L_j f_j \right)$$

A.5

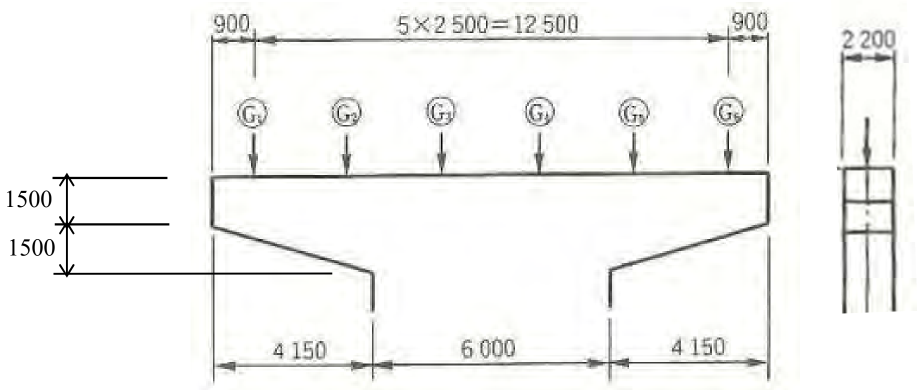
Q.6 Design of Beam of RC Pier

(1) Calculate bending moment worked at verification section of the beam for Vertical direction.
Here, load case is to be considered both of a) Dead+Live case and b) Dead only case

(2) Determine rebar arrangement of the beam at tension side by verification of bending stress of (a) and (b).

Supplemental Design Condition

Reaction force from girders to be applied for beam design is given as below.



	Dead load (kN)	Live load (kN)
Reaction force at G1 (G6)	1470	600
Reaction force at G2 (G5)	1470	600
Reaction force at G3 (G4)	1470	600

・Material properties

- Design standard concrete strength : σ_{ck}=24N/mm^2
- Type of reinforcement bar : SD345
- Diameter & Dimensions of bar :

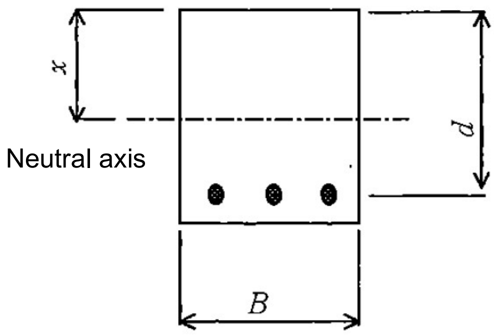
	Diameter (mm)	Dimension (mm^2/bar)
D19	19.1	286.5
D22	22.2	387.1
D25	25.4	506.7
D29	28.6	642.4
D32	31.8	794.2
D35	34.9	956.6

Table-4.3.1 Allowable Stresses of Reinforcing Bars (N/mm^2)

Type of Stress and Structural Member \ Type of Reinforcing Bar			SR235	SD295A SD295B	SD345
	1) In Cases of Principal Loads except Live Loads and Impacts (Beams, etc.)		80	100	100
Tensile Stress	Basic Values in Cases of Load Combinations without Collision or Seismic Effects	2) General Members	140	180	180
		3) Members in Water or Groundwater	140	160	160
	4) Basic Values in Cases of Load Combinations with Impacts or Seismic Effects		140	180	200
	5) Basic Values for Calculating Lap Joint Length or Anchoring Length of Reinforcing Bars		140	180	200
6) Compressive Stress			140	180	200

Supplemental Explanation

Formula of RC Section calculation



- Position of neutral axis

$$x = \frac{nA_s}{B}\left(-1 + \sqrt{1 + \frac{2Bd}{nA_s}}\right)$$

- Compressive stress of concrete

$$\sigma_c = \frac{2M}{Bx(d - \frac{x}{3})}$$

- Tensile stress of reinforcement

$$\sigma_s = \frac{M}{A_s(d - \frac{x}{3})}$$ or $$\sigma_s = n \cdot \sigma_c \frac{d - x}{x}$$

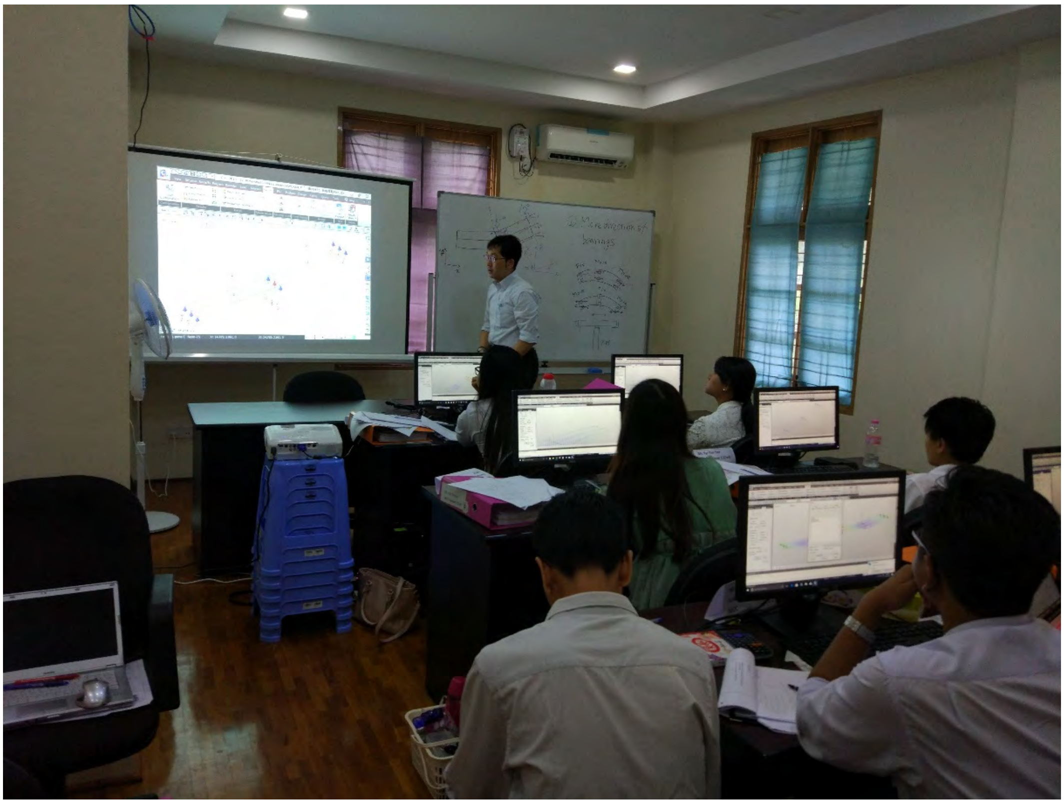
A.6

Appendix C Pictures

C-1 Pictures of Lectures and Seminars

Special Lecture by Emeritas Prof. Masatsugu Nagai (Nagaoka University of Technology)

Special Lecture by Prof. Eiji Iwasaki (Nagaoka University of Technology)



Structural Analysis General

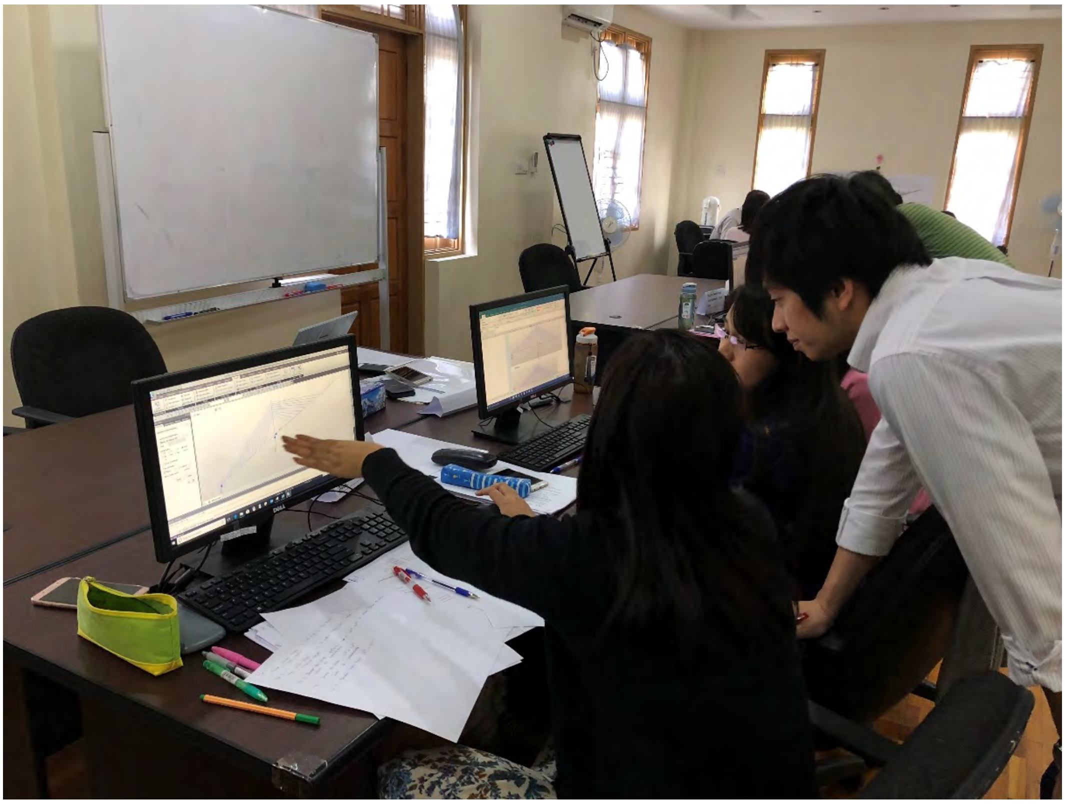
Superstructure Design (Concrete)

Superstructure Design (Steel)

Substructure Design

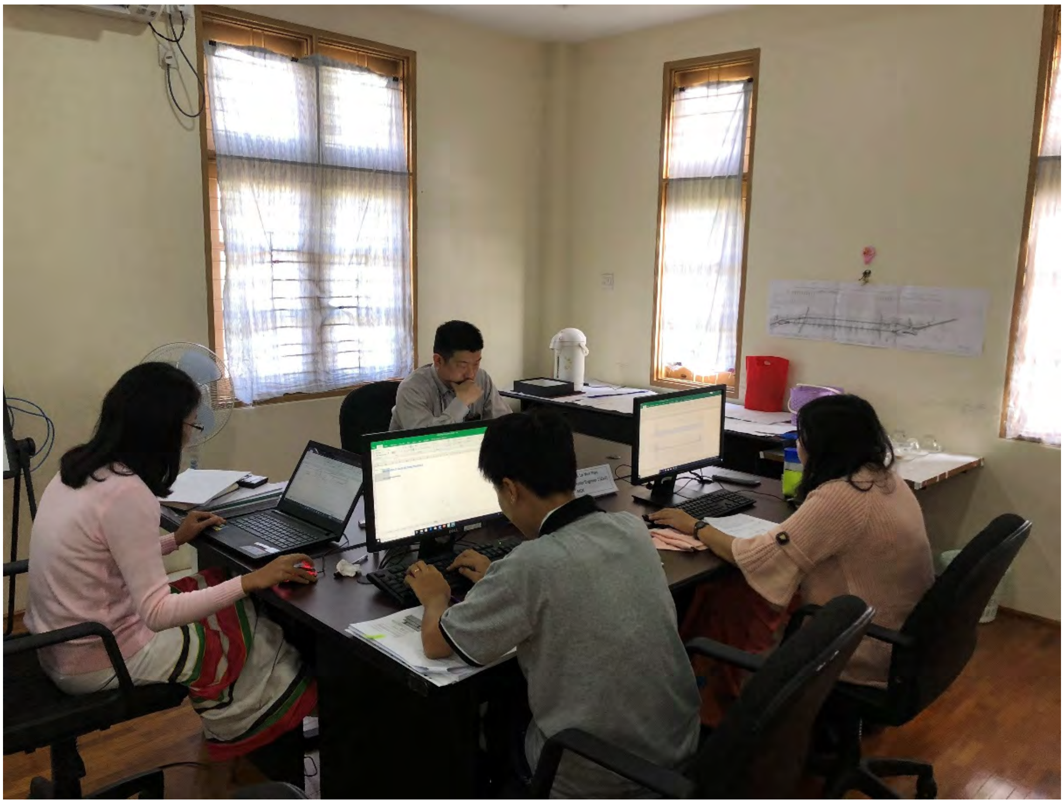
Seminar for Wind Tunnel Test by Prof. Hiromichi Shirato (Kyoto University)

Seminar for Cost Estimate



Detailed Practice for Steel Cable Stayed Bridge

Detailed Practice for Steel Box Girder Bridge



Detailed Practice for PC Box Girder Bridge

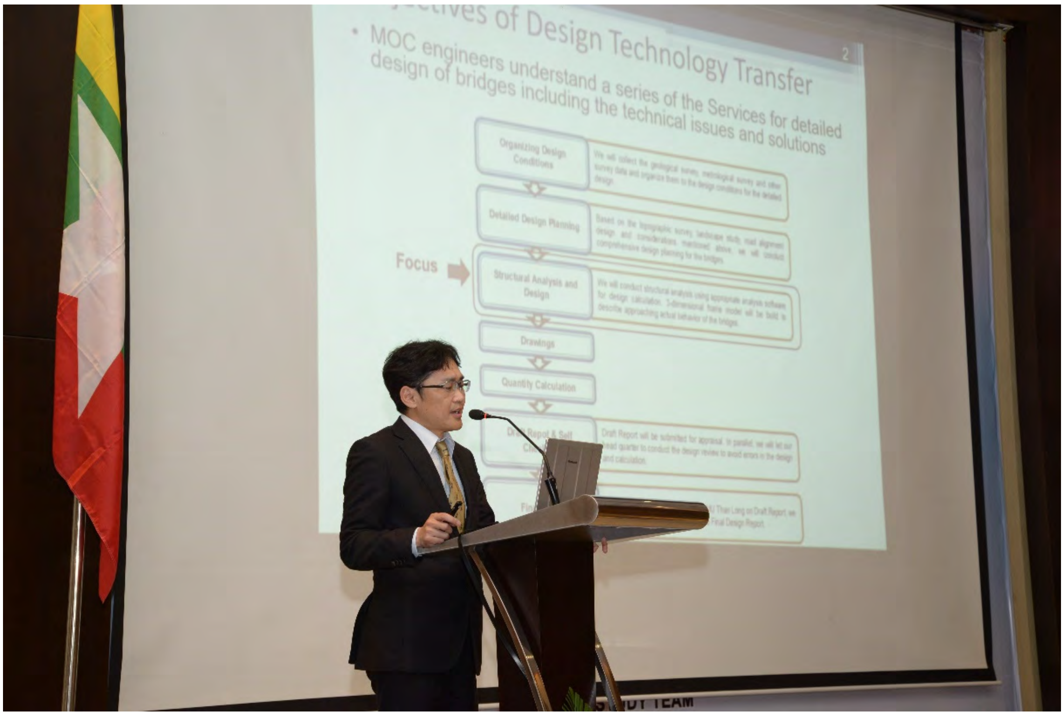
Detailed Practice for Foundation & Substructure

Appendix C Pictures

C-2 Pictures of Ceremony

Speech by Mr. Han Zaw (Union Minister of MOC)

Speech by Mr. Kotaro Nishigata (Senior Representative of JICA)



Speech by Mr. Yuichi Sano (Team Leader of JICA Study Team)

Speech by Emeritas Prof. Masatsugu Nagai (Nagaoka University of Technology)

Speech by Trainee, Ms. Ei Htwe San (Deputy Director (Civil) of MOC)

Speech by Trainee, Ms. Nant Thar Hmwe (Deputy Director (Civil) of MOC)

Distribution of Certificates

Closing Speech by Mr. Nay Aung Ye Myint (Deputy Director General of MOC)

Gift Session

Photo Session

Appendix D Attendance Sheet

Detailed Design Study on Bago River Bridge Construction Project

Design Technology Transfer

Attendance Record (1)

October ~ December , 2017

	Date	October											November																			December															Attendance Rate
		16	17	19	20	23	24	25	26	27	30	31	1	6	7	8	9	10	14	15	16	17	20	21	22	23	24	27	28	29	30	1	4	5	6	7	8	11	12	13	13	15	19	20	21	22	
	Lecture	Special Lecture										Seminar											Special Lecture															Semi nar	Special Lecture								
1	Daw Ei Htwe San Deputy Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	98%
2	Daw Nant Tha Hmwe Assistant Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	98%
3	Daw San Phyu Phyu Saw Assistant Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
4	Daw Yu Yu Naing Staff Officer (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	98%
5	Daw Lai Mon Phyo Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	○	98%
6	Daw Kyi Thar Soe Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
7	Dr. Hay Man Myint Maung Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	-	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	93%
8	Daw Htet Tint Wai Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
9	Daw Shwe Yamin Myat Junior Engineer (3) (Civil)	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	-	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	-	○	○	○	89%
10	U Hein Zaw Junior Engineer (4) (Civil)	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	-	○	○	○	93%
11	Daw Swe Hnin Aye Junior Engineer (1) (Civil)																		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
12	Daw Hnin Ei Ei Chaw Junior Engineer (2) (Civil)																		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
13	Dr. Khin Su Su Htwe Professor (YTU)	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	U Phyo Hein Kyaw Ph.D (Thesis) (YTU)	○	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	Daw Hnin Yadanar Kyaw Junior Engineer (1) (Civil)											○	○										○	○	○	○	○											○	○	-	-	-	-				
16	Daw Htoo Eain Lwin Staff Officer (Civil)											○	○										○	○	○	○	-											-	-	-	-	-	-				
17	Daw Swe Hnin Aye Junior Engineer (1) (Civil)											○	○																																		
18	Daw Hnin Ei Ei Chow Junior Engineer (2) (Civil)											○	–																																		

Detailed Design Study on Bago River Bridge Construction Project

Design Technology Transfer

Attendance Record (2)

January ~ February , 2018

Date		January																		February																			Attendance Rate
		8	9	10	11	12	15	16	17	18	19	22	23	24	25	26	29	30	31	1	2	5	6	7	8	9	13	14	15	16	19	20	21	22	23	26	27	28	
Lecture									Special lecture																									Special lecture	Ceremony			Presentation	
Detailed Practice for Steel Cable Stayed Bridge																																							
1	Daw Ei Htwe San Deputy Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	95%
2	Daw Nant Tha Hmwe Deputy Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	95%
Detailed Practice for Steel Box Girder Bridge																																							
3	Dr. Hay Man Myint Maung Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	-	-	○	○	○	○	-	-	-	○	○	○	○	○	○	○	○	○	○	84%
4	Daw Shwe Yamin Myat Junior Engineer (3) (Civil)	○	○	○	○	○	○	-	○	○	○	○	○	○	-	○	○	○	○	-	-	-	○	○	○	○	○	○	○	○	-	-	○	○	○	○	○	○	81%
Detailed Practice for PC Box Girder Bridge																																							
5	Daw Lai Mon Phyo Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	97%
6	Daw Kyi Thar Soe Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
Detailed Practice for Foundation & Substructure																																							
7	Daw San Phyu Phyu Saw Assistant Director (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
8	Daw Yu Yu Naing Staff Officer (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	○	97%
9	Daw Swe Hnin Aye Junior Engineer (1) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
10	Daw Hnin Ei Ei Chaw Junior Engineer (2) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	100%
11	U Hein Zaw Junior Engineer (4) (Civil)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	-	○	○	○	○	○	○	○	○	○	○	○	97%