SOCIALIST REPUBLIC OF VIET NAM
PROJECTS MANAGEMENT UNIT NO.2

FINAL REPORT

FOR ROAD & BRIDGE PORTION ON LACH HUYEN PORT INFRASTRUCTURE CONSTRUCTION PROJET IN VIET NAM

(Vol. 2 of 2)

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Japan International Cooperation Agency (JICA)

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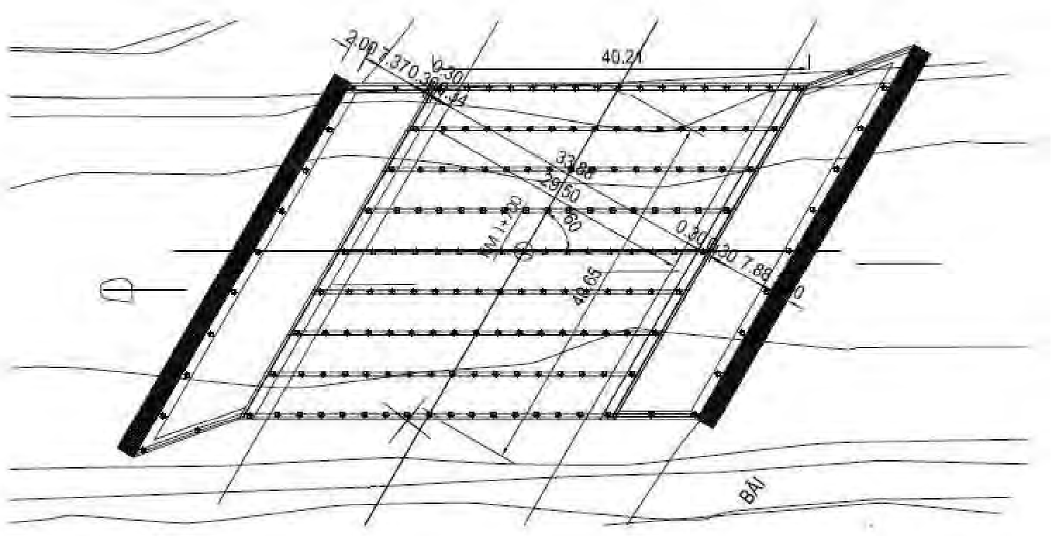
8.5.1 Background

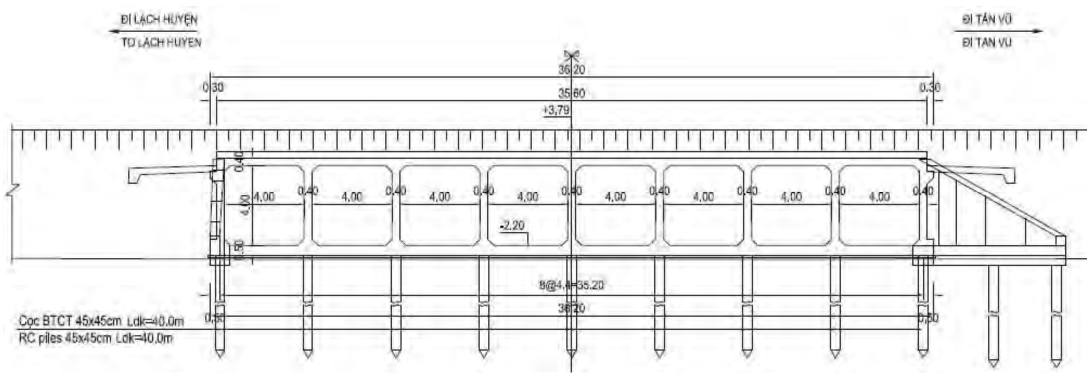
Tan Vu – Lach Huyen Highway is crossing Cam River at Km 1+700 and a box culvert with 8 cells, 8 x (4m x 4m), was planned, which is approved by 3139/QD-BGTVT dated 29th of October, 2010. The plan view and crosssection of box culvert is shown in the figure below.

On 5th of August, 2011, a meeting was held between Hai Phong PC and JICA Study Team, chaired by Mr Le Van Thanh, Vice Chairman, and concluded that the box culvert would be replaced by a bridge as stated in Notice No.242-TB/UBND dated 8th of August, 2011.

In accordance with the conclusion, a study was conducted to select an appropriate bridge type for crossing Cam River.



(b) Plan View



(b) Crosssection

Source: Study Team

Figure 8.5.1-1 Cam River Box Culvert

8.5.2 General Plan and Site Conditions of Cam River Bridge

In this chapter, appropriate general plan of the bridge is determined based on topographic hydrological conditions.

(1) Topographic Conditions

The figure below shows the topographic profile of Cam River. The lowest point is GL-2.2 at Km 1+700.

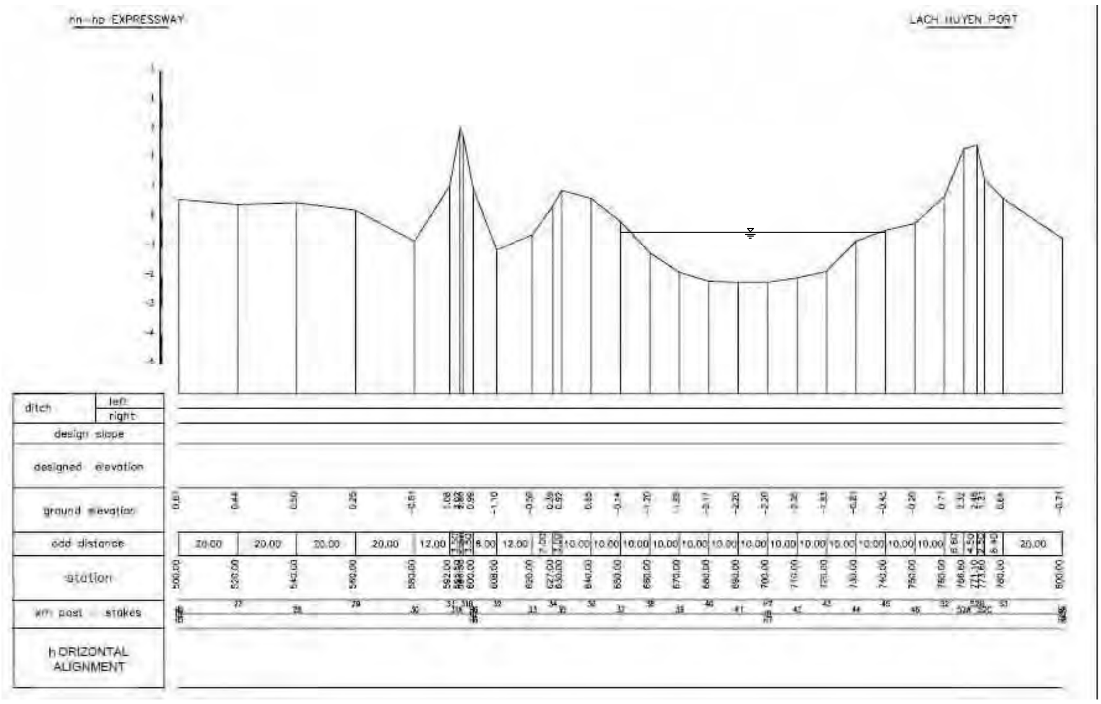


Figure 8.5.2-1 Topographic Profile of Cam River (Km 1+700)

(2) Hydrological Conditions

The hydrological conditions of Cam River at the intersection with Tan Vu – Lach Huyen Highway are summarized as follows;

Table 8.5.2-1 Hydrological Conditions of Cam River

Items	Quantities/ Values	Note
Design Discharge, Q*	176 m^3	Design Frequency, P =: 1%
Design Velocity, V	0.39 m/s	Design Frequency, P = 1%
Necessary Width for Drainage, W	51.35 m	Perpendicular to Flow Direction
Angle between Directions of River and Highway	59 degree	

* Based on Article 2.2.3 “Supplemental Hydrological Survey” in Basic Design Report

(3) Length of Bridge

The length of the bridge is defined based on the necessary width for drainage, W=51.35m, shown in the table above and the skew angle, θ=59 degree, parallel to the river front.

As shown in the plan view below, the bridge length is defined as 69.2m.

(4) Soil Conditions

The ground conditions by D/D study are shown in below illustrations and following tables.

Table 8.5.2-2 Soil Condition at Boring No.BA-13 and BA-14

Layer Name	Soil Type	Average N-Value	Wet Density Above Water Level γ (kN/m3)	Wet Density Under Water Level γ (kN/m3)	Shear Strength C (kN/m2)	Internal Friction ϕ (degree)	Horizontal Spring Constant αE0 (kN/m2)
3	Lean Clay	1	17.0	8.0	12.0	-	5600
4	Lean Clay	3	18.0	9.0	42.0	-	19600
6	Sandy Clay	16	19.0	10.0	78.0	-	36400
L6-1	Silty Sand	>50	19.0	10.0	78.0	30.0	36400
7B	Silt	7	18.0	9.0	42.0	-	19600
8	Lean Clay	14	19.0	10.0	84.0	-	39200
9	Clay	6	18.0	9.0	36.0	-	16800
10B	Silty Sand	>50	21.0	12.0	-	40.0	137200

Source: Study Team

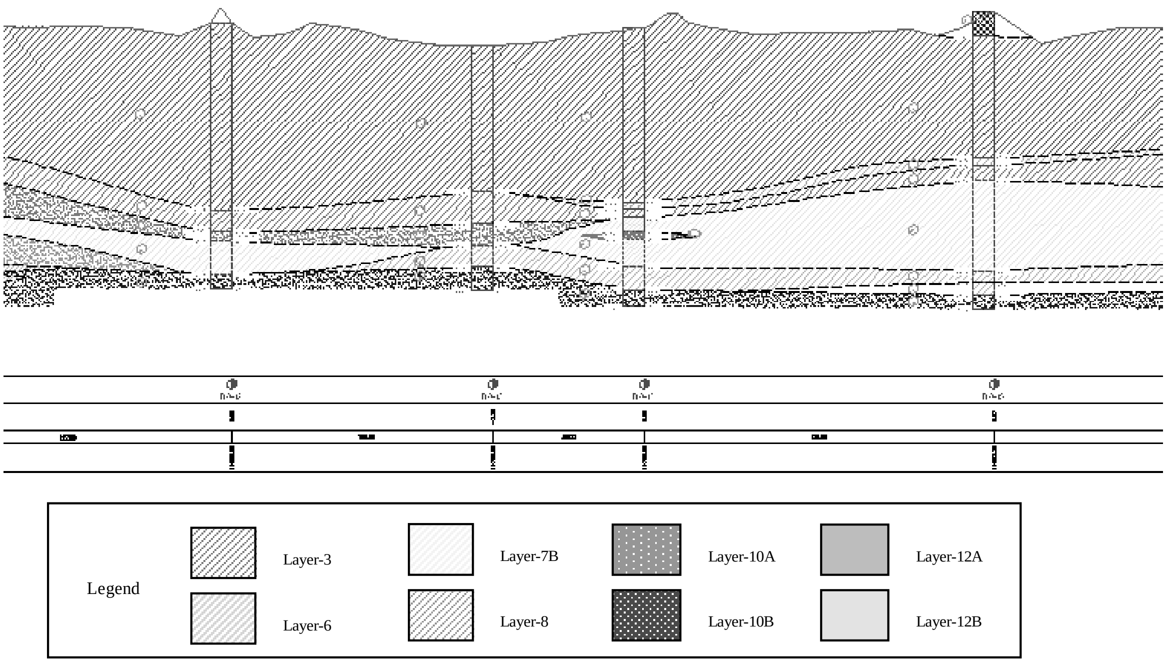


Figure 8.5.2-2 Soil Profile adjacent to Cam River (Km 1+700)

(5) Scour Depth

Total scour from superposition of components is given by

$y_s = y_{s\ pier} + y_{s\ pc} + y_{s\ pg}$

y_s : Total scour depth, m

$y_{s\ pier}$: Scour component for the pier stem in the flow, m

$y_{s\ pc}$: Scour component for the pier cap of footing in the flow, m

$y_{s\ pg}$: Scour component for the piles exposed to the flow, m

Scour component for the pier stem in the flow is given by

$y_{s\ pier} = K_{h\ pier} [2.0\ K_1\ K_2\ K_3\ K_4\ a_{pier}^{0.65}\ y_1^{0.35}\ Fr_1^{0.43}]$

$Fr_1 = V_1 / (g.y_1)^{0.5}$

$K_{h\ pier}$:Coefficient to account for the height of the pier stem above the bed and the shielding effect by the pile cap overhang distance "f" in front of the pier stem

$K_{h\ pier} = (0.4075 - 0.669\ f/a_{pier}) - (0.4271 - 0.778\ f/a_{pier})\ h1/a_{pier} + (0.1615 - 0.455\ f/a_{pier})(h_1/a_{pier})^2 - (0.0269 - 0.012\ f/a_{pier})(h_1/a_{pier})^3$

Scour component for the pier cap of footing in the flow is given by

$y_{s\ pc} = 2.0\ K_1\ K_2\ K_3\ K_4\ K_w\ a^*_{pc}{}^{0.65}\ y_2^{0.35}\ Fr_2^{0.43}$

$Fr_2 = V_2 / (g.y_2)^{0.5}$

Scour component for the piles exposed to the flow is given by

$y_{s\ pg} = K_{h\ pg} [\ 2.0\ K_1\ K_2\ K_3\ K_4\ a^*_{pg}{}^{0.65}\ y_3^{0.35}\ Fr_3^{0.43}]$

Where:

Δy_{xcb} : Level after scour, m

y_1 : Flow depth directly upstrream of the pier, m

K_1 : Correction factor for pier nose shape

K_2 : Correction factor for angle of attack of flow

K_3 : Correction factor for bed condition

K_4 : Correction factor for armoring by bed material size (only with D_{50} = > 60 mm)

a : Pier width, m

V_1 : Mean velocity of flow directly upstream of the pier, m/s

K_w : Wide pier factor

K_{sp} : Coefficient for pile spacing

F_{rf} : Froude number

$F_{rf} = V_f / (g.y_f)^{0.5}$

g : Acceleration of gravity (9.81 m/s^2)

V_f : average velocity in the flow zone below the top of the footing, m/s

V_2 : average adjusted velocity in the vertical of flow approaching the pier, m/s

K_m : Coefficient for number of aligned rows, m

(K_m = 1 for skewed or staggered pile group)

The parameters for calculation of the scour depth are shown in the table below.

Table 8.5.2-3 Calculation of Scour Depth

Local pier scour equation

$H_{1\%}$ = 2.50 m (ii)

No.	$\nabla_{trô}$	y_1	V_1	Fr_1	f	a_{pier}	$K_{h\,pier}$			K1		K_2			K_3		K_4			$y_{s\,pier}$
Trô	(m)	(m)	(m/s)		(m)	(m)	h_0 (m)	h_1 (m)	$K_{h\,pier}$	HD mòi trô	K_1	θ (⁰)	L (m)	K_2	§¸y s«ng	K_3	D_{50} (mm)	D_{95} (mm)	K_4	(m)
P1	-2.20	4.70	0.53	0.078	0.70	1.80	-3.03	-1.03	0.661	vu«ng	1.1	0	10.00	1.0	b»ng ph¼ng	1.1	0.08	0.35	1.00	1.35
P2	-2.05	4.55	0.52	0.078	0.70	1.80	-3.18	-1.18	0.711	vu«ng	1.1	0	10.00	1.0	b»ng ph¼ng	1.1	0.08	0.35	1.00	1.43

Pier stem depth Component

$H_{1\%}$ = 2.50 m (iii)

No.	y_1	V_1	T	h_2	k_s	y_2	V_2	Fr_2	a_{pc}	a^*_{pc}	K_1		K_2			K_3	K_4	K_w		$y_{s\,pc}$
Trô	(m)	(m/s)	(m)	(mm)	(mm)	(m)	(m/s)		(m)	(m)	HD mòi trô	K_1	θ (⁰)	L (m)	K_2			D_{50} (mm)	K_w	(m)
P1	4.70	0.53	2.00	-2.36	0.250	5.37	0.46	0.064	2.05	1.58	vu«ng	1.1	0	10.00	1.0	1.1	1.00	0.08	1.00	1.72
P2	4.55	0.52	2.00	-2.47	0.250	5.26	0.45	0.062	2.05	1.83	vu«ng	1.1	0	10.00	1.0	1.1	1.00	0.08	1.00	1.85

The total scour depths and the elevations at the piers, P1 and P2 are summarized in the table below.

Table 8.5.2-4 Total Scour Depth

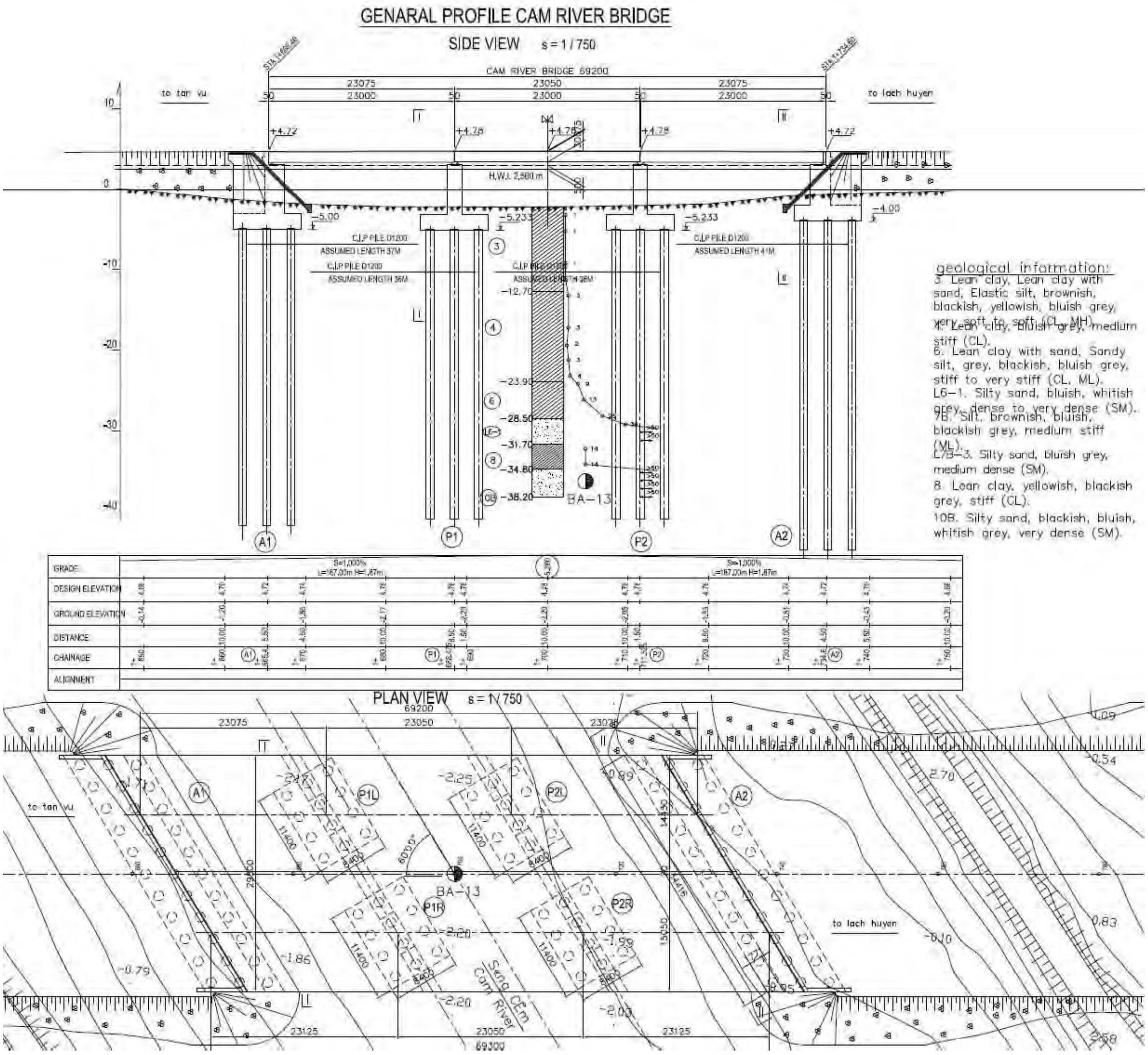
Pier No.	Total Scour Depth y_s (m)	River Bed Elevation after scour (m)
P1	3.06	-5.26
P2	3.27	-5.32

(6) Span Length and Type of Girder

Regarding span component and bridge type, it was judges that 3 spans continuous or simply supported girder is reasonable from technical & economical view points. After comparison on three (3) alternatives as shown in the Discussion paper No.15, PC Hollow slab girder was selected from aesthetic & economical view point. However, according to the site conditions, DRVN and PMU-2 insisted that pre-cast girder shall be adopted. Finally, PC T girder simply supported was adopted and designed. (Concrete volume of PC T girder is less than PC Hollow slab girder, box girder and PC I girder with cast-in-situ deck slab.)

(7) General Plan

The general plan of Cam River Bridge is as shown in the figure below.



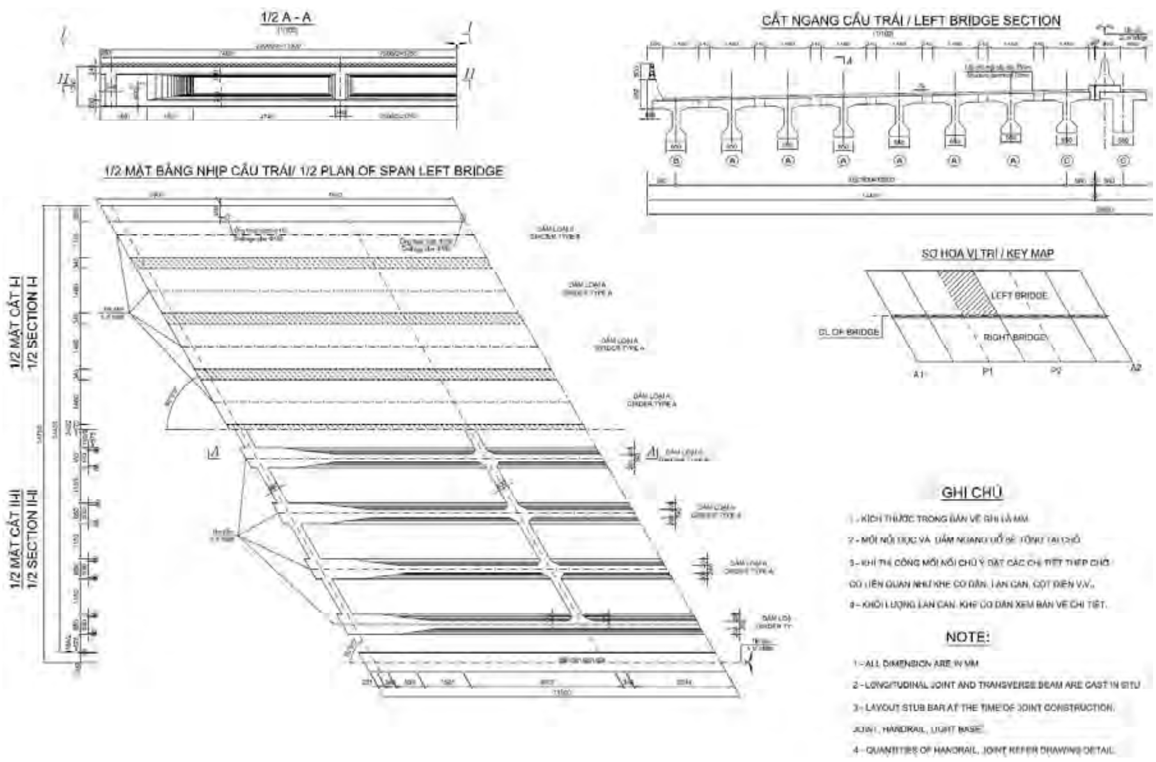
Source: Study Team

Figure 8.5.2-3 General view of Cam River Bridge

8.5.3 Design of Superstructure

(1) Girder Arrangement

The girder arrangement is as shown in the figure below.



Source : Study Team

Figure 8.5.3-1 Girder Arrangement

(2) Design conditions

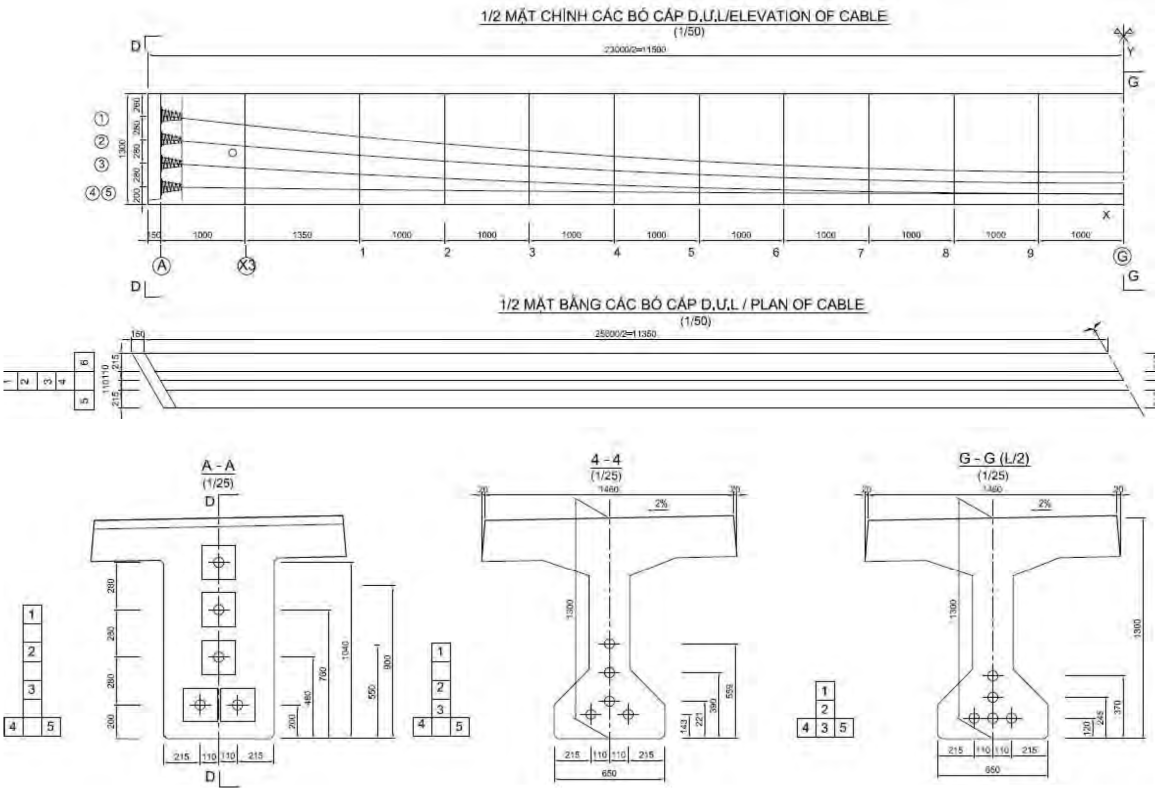
- Bridge Type: Prestressed Concrete Bridge
- Structure Type: PC simply supported T girder
- Length: 3@23.0 = 69m
- Design Speed: 80km/h
- Construction Method: Post tension Pre-cast girder
- Erection Method: Erection girder
- Live Load: 22TCN-272-05 (AASHTO LRFD)
- Width Composition: 15.050m for design

(3) Material to be used (common to main & approach bridge)

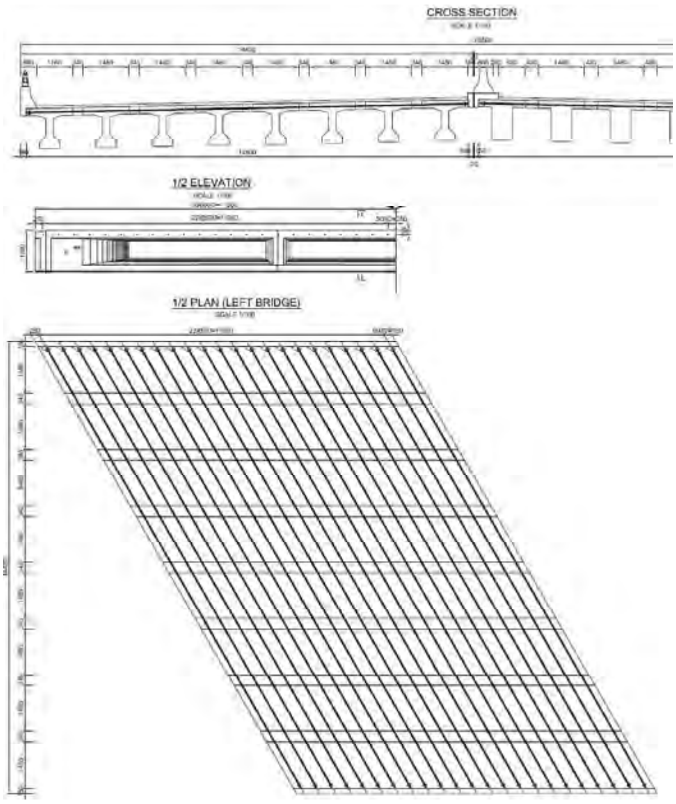
See the article 8.1.2 in this report.

(4) Tendon Arrangement

The tendon arrangement in is as shown in the figure below.



(a) Longitudinal PC Tendons



(b) Transversal PC Tendons

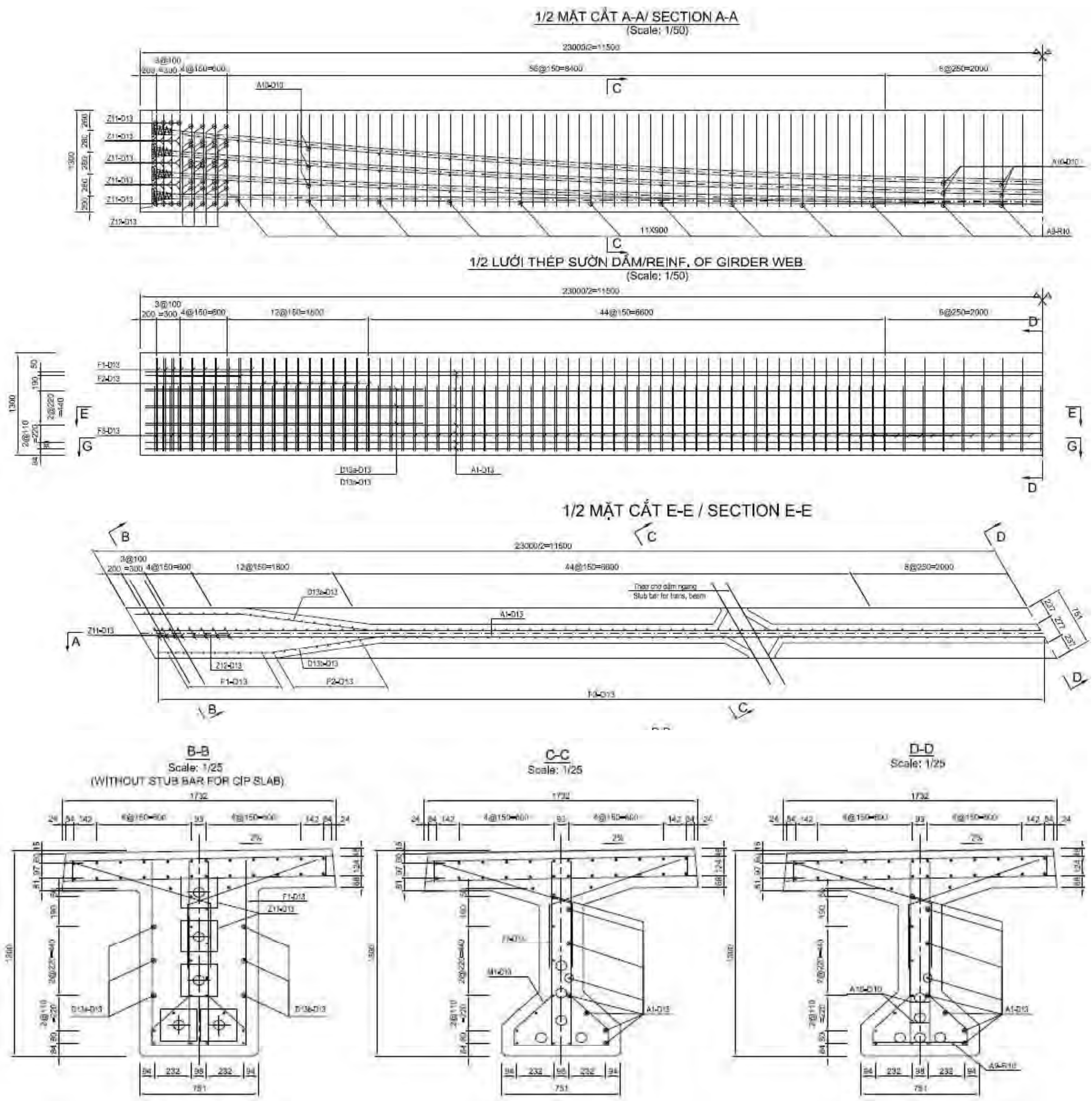
Source: Study Team

Figure 8.5.3-2 Arrangement of PC Tendons

(5) Results of Design

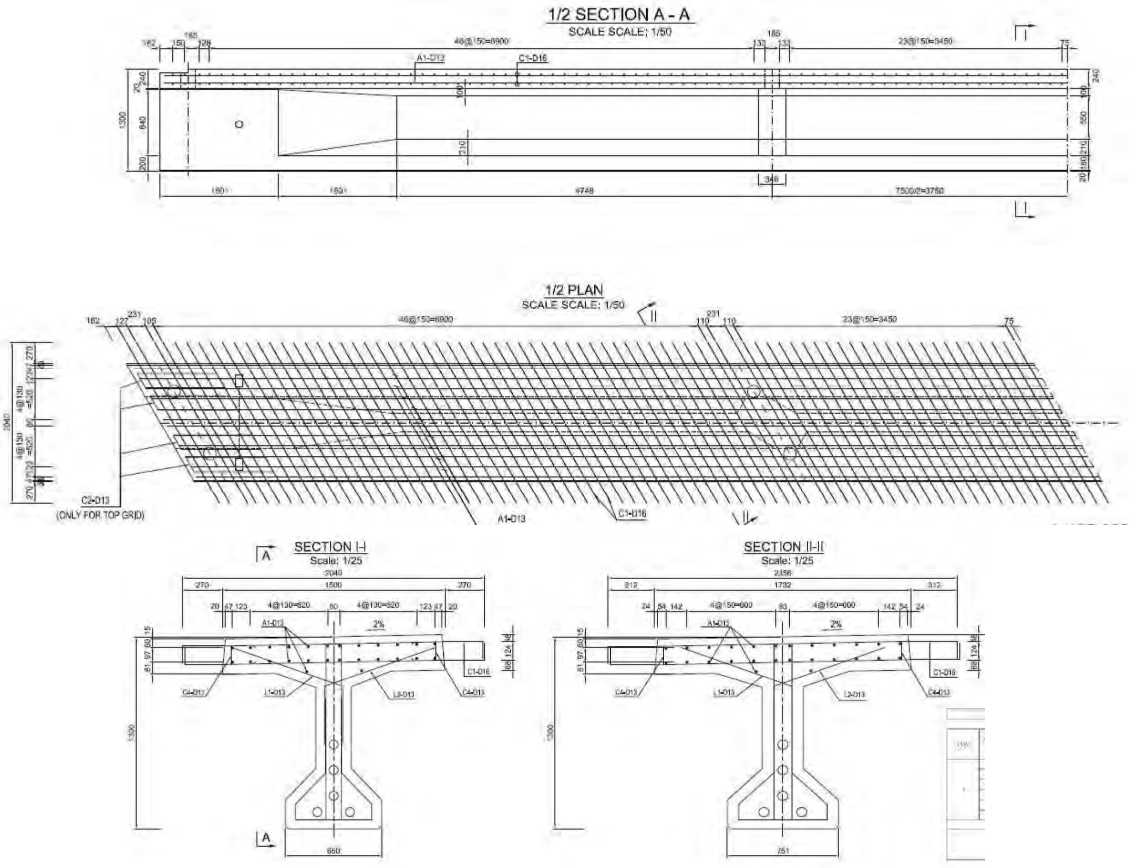
Detailed design conditions and calculation is shown in Design Report on Cam River Bridge.

The resultant reinforcement is as shown in the figures below.



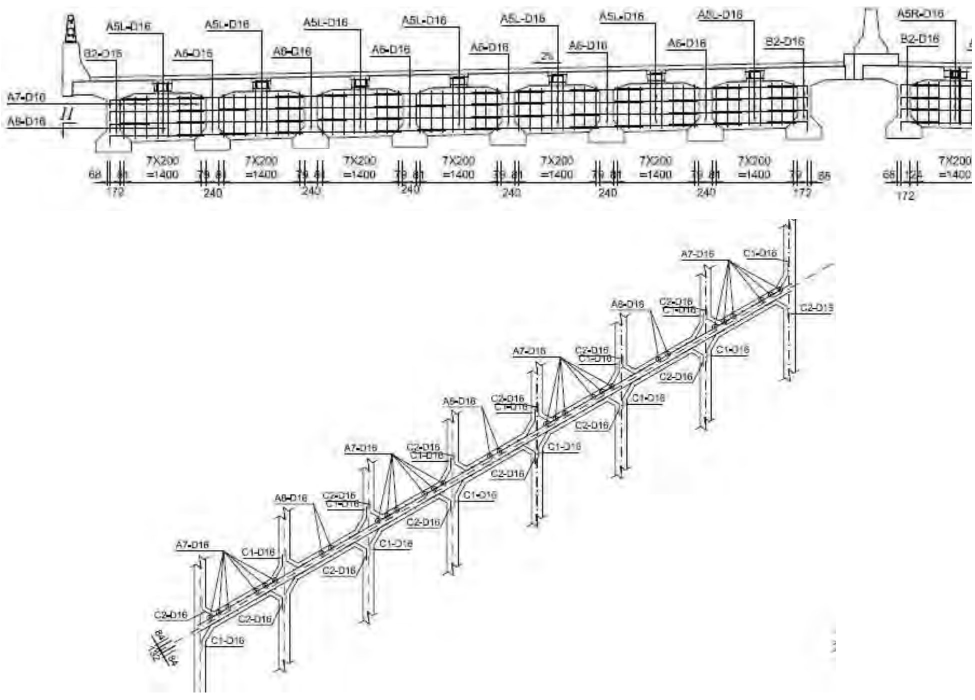
Source: Study Team

Figure 8.5.3-3 Reinforcement for Web of Girders



Source: Study Team

Figure 8.5.3-4 Reinforcement for Flange of Girders



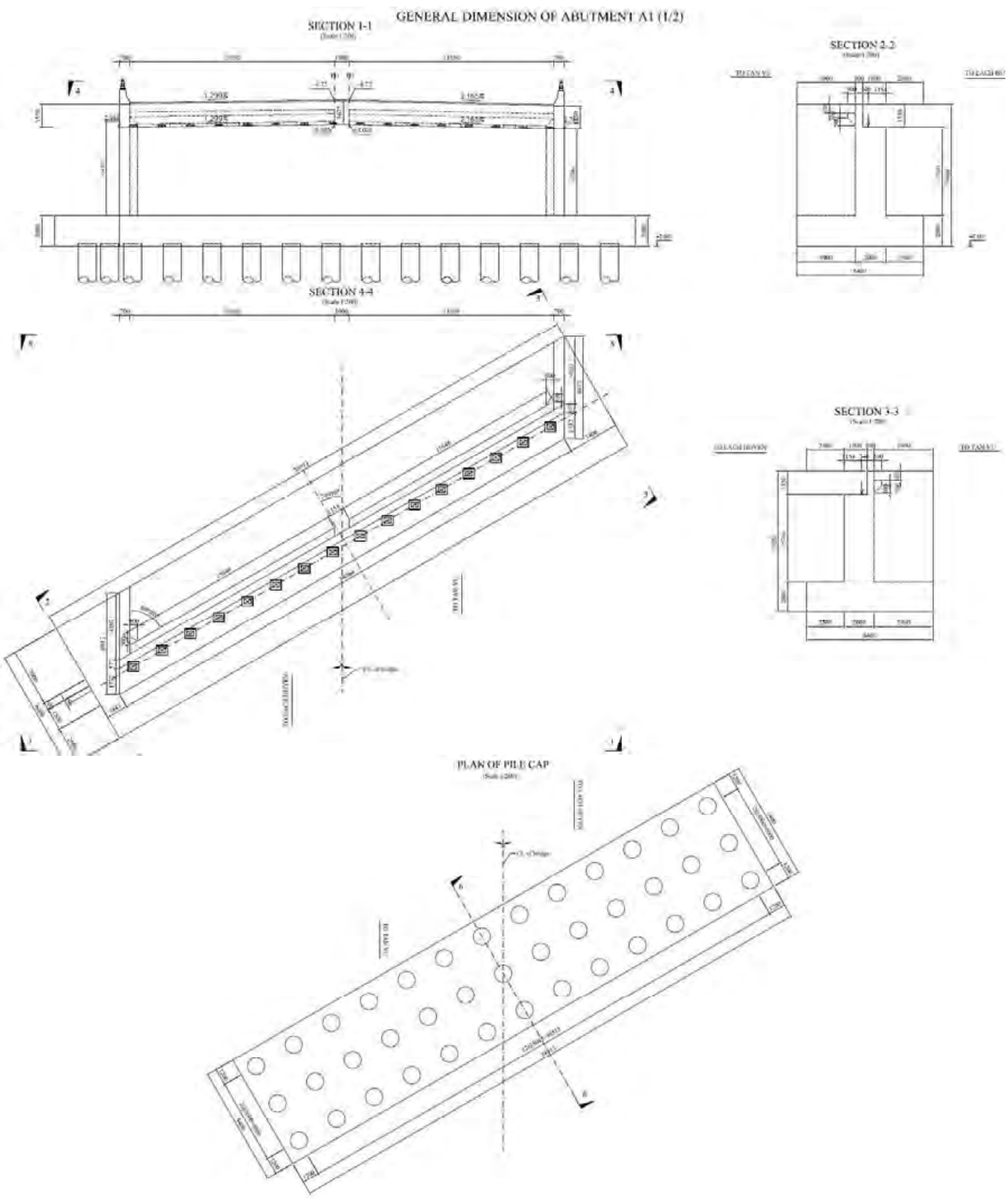
Source: Study Team

Figure 8.5.3-5 Reinforcement for Cross Beam of Girders

8.5.4 Design of Substructure

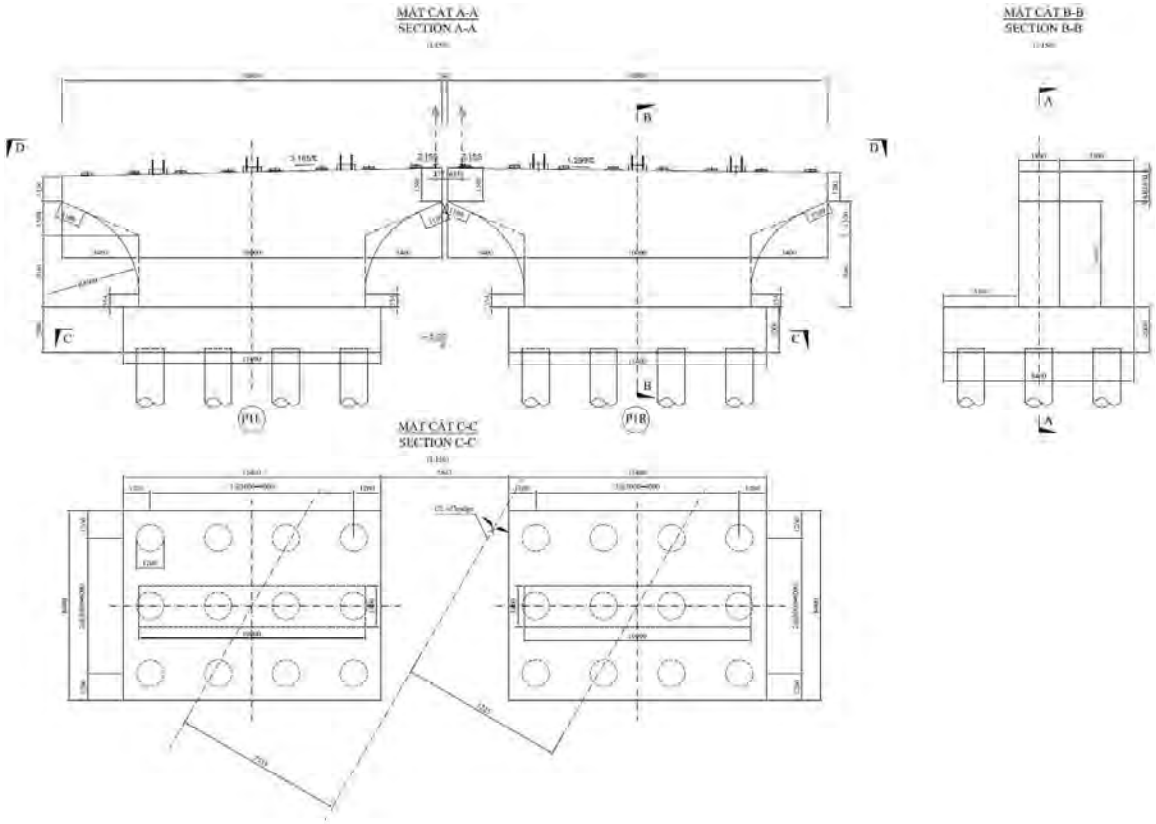
(1) Structure Dimensions

The Dimensions of substructure are as shown in the figure below.



Source : Study Team

Figure 8.5.4-1 Dimensions of Abutment



Source : Study Team

Figure 8.5.4-2 Dimensions of Pier

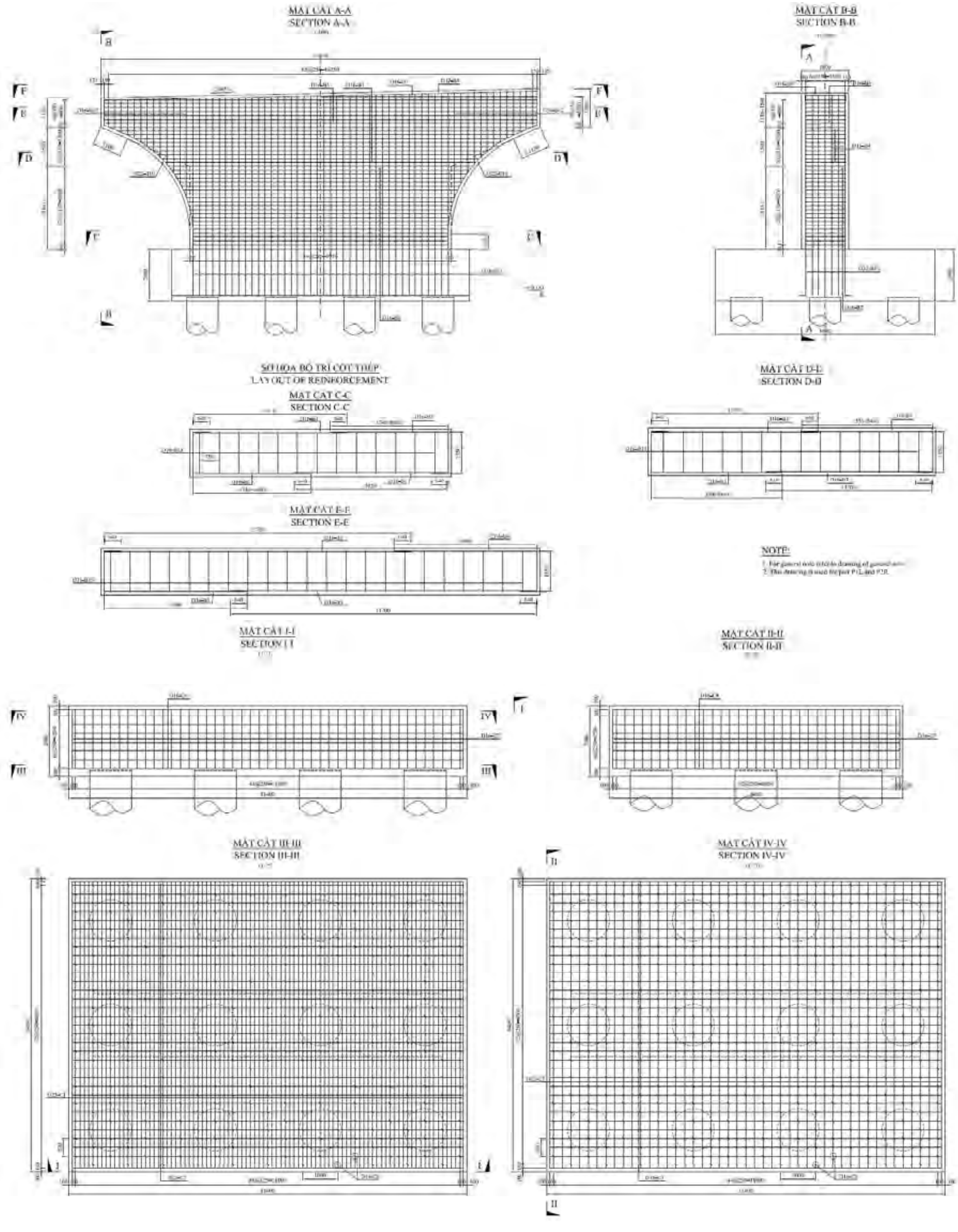
(2) Material to be used (common to main & approach bridge)

See the article 8.1.2 in this report.

(5) Results of Design

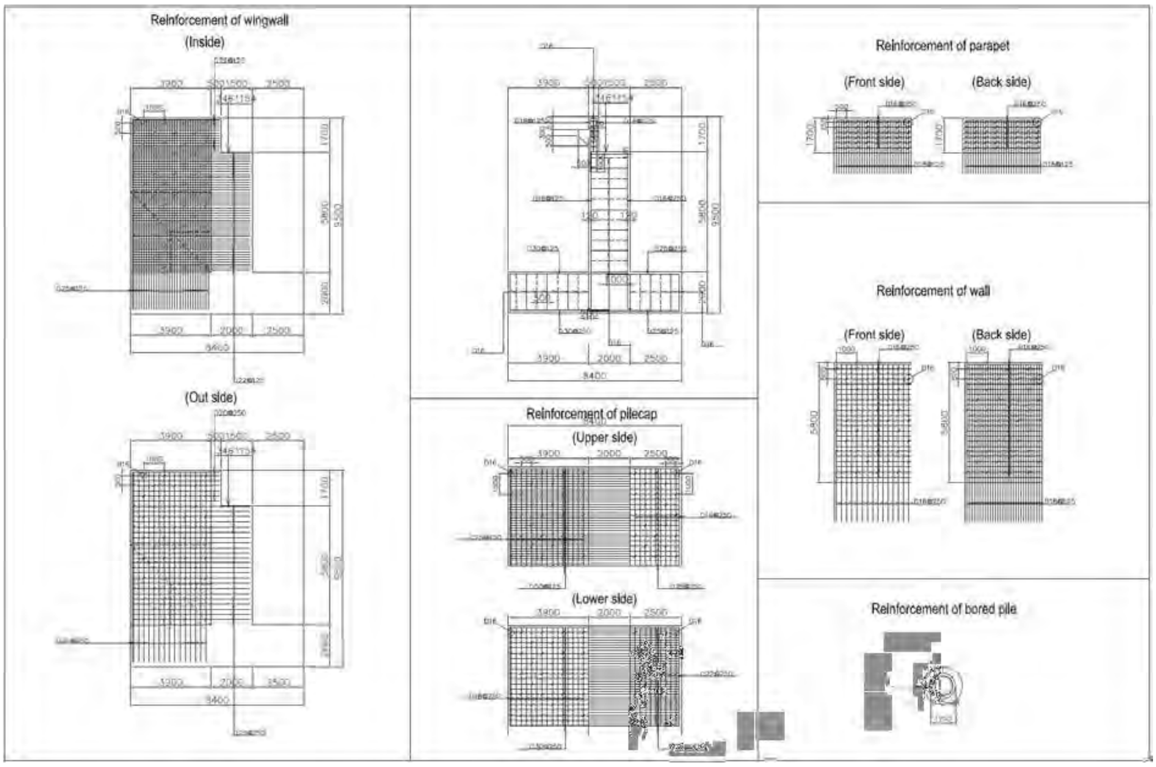
Detailed design conditions and calculation is shown in Design Report on Cam River Bridge.

The resultant reinforcement is as shown in the figures below.



Source: Study Team

Figure 8.5.4-3 Reinforcement of Pier



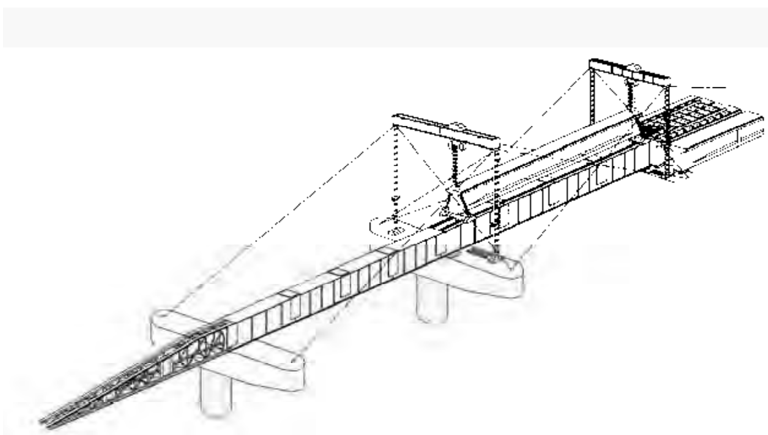
Source : Study Team

Figure 8.5.4-4 Reinforcement of Abutment

8.5.5 Precast T Girder Erection Method

On the Cam River, 3 continuous PC Post tension T girders will be constructed by erection girder after fabricating PC Girder behind abutment.

Outline of erection is shown below.



Source: Study Team

Figure 8.5.5-2 PC T girder erection method