Ministry of Transport (B.GTVT)

Vietnam Expressway Corporation (VEC)

Project Management Unit No. 85 (PMU. 85)

THE WORLD BANK

IDA Credit No. / IDA tín dụng số : 4779-VN
Project ID No. / Mã dự án: P106235

Consulting Services for / Dịch vụ tư vấn
Detailed Design for Da Nang - Quang Ngai Expressway Development Project
/ Thiết kế kỹ thuật dự án **Đường** cao tốc **Đà** Nẵng – Quãng Ngãi

DETAILED DESIGN / THIẾT KẾ KỸ THUẬT
PACKAGE / GÓI THẦU: PKG3A (Km16+880.00 -:- Km18+100.00)

VOLUME 1: DESIGN REPORT / TẬP 1: THUYẾT MINH THIẾT KẾ

(Updated in according to Decision No.439/QĐ-VEC, on November/23/2012 /
Hoàn thiện theo quyết định duyệt số 439/QĐ-VEC, ngày 23/11/2012)

November, 2012 / Tháng 11, 2012

The Joint Venture of / Liên danh Tư vấn:

NIPPON KOEI CO.,LTD.
NIPPON ENGINEERING CONSULTANTS CO.,LTD.
CHODAI CO.,LTD.
THAI ENGINEERING CONSULTANTS CO., LTD.

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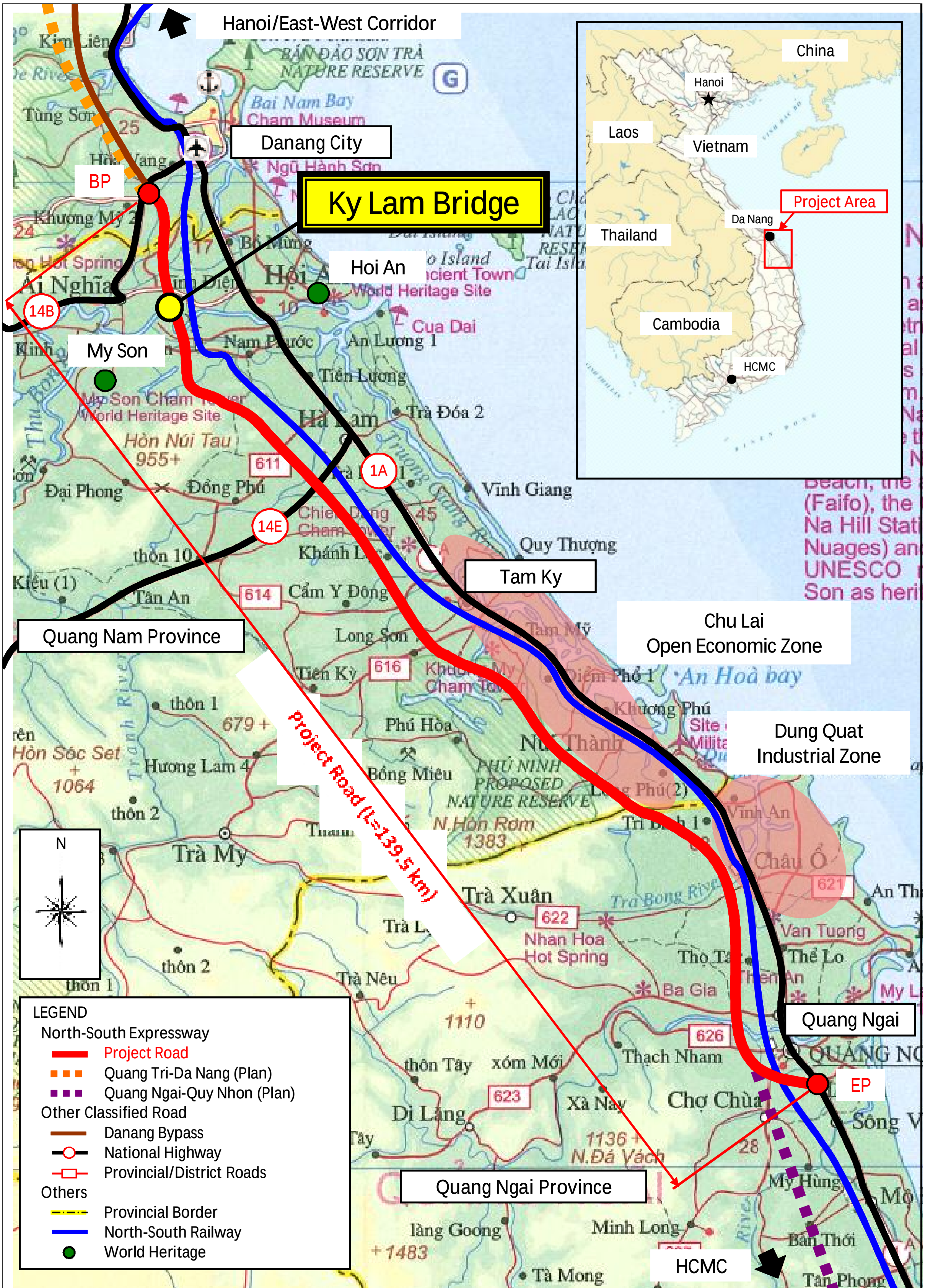
	Prepared by / Thực hiện	Checked by / Kiểm tra	Approved by / Duyệt
Name / Tên	Nguyen Van Le	Hiroyuki Yokoyama	Yoshito Oba
Signature / Chữ ký			
Date / Ngày			

THE JOINT VENTURE OF NK-NE-CHODAI-TEC / LIÊN DANH TƯ VẤN

Project Manager / Giám đốc Dự án

Ichizuru Ishimoto



Consulting Services for Detailed Design for Danang Quang Ngai Expressway Development Project (DQEDP-DD)	Project Location Map

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List of Abbreviations

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D/D	:	Detailed Engineering Design
DHWL	:	Design High Water Level
DQE	:	Da Nang - Quang Ngai Expressway
F/S	:	Feasibility Study
GOVN	:	Government of Vietnam
IBRD	:	The International Bank for Reconstruction and Development
MOT	:	Ministry of Transport
NH	:	National Highway
PC	:	Pre-stressed Concrete
PKG	:	Package
PMU	:	Project Management Unit
QCVN	:	Vietnamese National Standards
RNIP	:	Road Network Improvement Project
TCN	:	National Technical Regulations
TEDI	:	Transport Engineering Design. Incorporated
TOR	:	Terms of Reference
VEC	:	Vietnam Expressway Corporation
WB	:	The World Bank

1 GENERAL

1.1 Introduction

Ky Lam bridge is crossing the Thu Bon river at Km17+502.80 on the Da Nang - Quang Ngai Expressway in Dien Ban district, Quang Nam Province. This is an important project in the development program of national expressway system which connect the regions and the economic center of the country.

1.2 Scope

- Ky Lam Bridge is under Package 3A, DQEP.
- Beginning point of Package: Km16+880.00
- Ending point of Package : Km18+100.00

2 LEGAL *BASIS*

- Decree 12/2009/NĐ - CP dated 12th February 2009 by Government on Management of Works Investment and Decree83/2009/NĐ-CP dated 15th Octocber 2009 of Government onrevision and adjustment of some articles in Decree 12/2009/NĐ-CP;
- Decree 112/2009/NĐ-CP dated 14th December 2009 by Government onmanagement of Works Investment;
- Decree 209/2004/NĐ-CP dated 16th December 2004 by Government regarding Contruction quality management; and Decree No.49/2008/NĐ-CP dated 18th April 2008 regarding revision and addtion of several articles of Decree No.209/2004/NĐ-CP;
- Decision No.362/QĐ-BGTVT dated 20th February 2009 and Decision No.727/QĐ-BGTVT dated 6th April 2012 by MOT regarding approval for Technical standard list applied for DQEP;
- Decision 2656/QĐ-BGTVTdated 10th September 2010 of MOT on approval on Investment of Da Nang- Quang Ngai Expressway Project.
- Decision No. 315/QĐ-BGTVT dated 23rd February 2011 of the Ministry of Transport on promulgating the selection guide technical and scale of rural roads for the national target program of new rural construction phase 2010 - 2020;
- Letter No. 353/SGTVT-KHTC dated 3rd April 2012 of Quang Nam Department of Transportation regarding the river class related to Da Nang - Quang Ngai Expressway Project;
- Letter No. 7324/BGTVT-CQLXD dated 5th September 2012 of MOT on Modifications of some iterms under basic design of backage 3A, A4 of Da Nang – Quang Ngai Expressway Project;
- Letter No.1238/CQLXD-TD dated 15th October 2012 of TCQM regarding the comments on Detail Design report of Package 3A in Da Nang - Quang Ngai Expressway Project;
- Letter No.2693/VEC-KTCNMT dated 11st October 2012 of VEC regarding explanations for the comments on detail design reports of Package 3A in Da Nang - Quang Ngai Expressway Project.
- Appraisal report No. 238/BC-KTCNMT dated 23thNovember 2012 of VEC regarding appraisal Detail design of Package 3A: Km16+800÷Km18+100 under Da Nang - Quang Ngai Expressway Project.
- Decision No.439/QD-VEC dated 23th November 2012 of VEC regarding approval on Detail design of Package 3A: Km Km16+800÷Km18+100- Ky Lam bridge, under Da Nang - Quang Ngai Expressway Project.

3 NATURAL CONDITION SURVEYS

3.1 Topographic Surveys

- See to Topographic Surveys Report

3.2 Geotechnical and Geological Survey

- See to Geotechnical and Geological Survey Report

3.3 Hydrological and Inundation Analysis

- See to Hydrological and Inundation Analysis Report

4 CONSTRUCTION *SCALE AND SPECIFICATIONS*

4.1 Construction Scale

Table 4. Construction Scale

No.	Iterm	Design Perameter
1	Construction Scale	Permanent bridge of RC and prestressed RC
2	Flood frequence	P1%
3	Design standard	22TCN272-05
4	Design Live load	HL-93
5	Seismic class	class 7, Acceleration Coefficient A =0.0341
6	Bridge width	B=0.5+12.0+1.0+12.0+0.5=26.0m
7	Navigation clearance	River class IV
8	Bridge centerline	Bridge centerline is 45^{o} to the flow
9	Road class	Expressway, type A
10	Design speed	V=120km/h
11	Geometric elements and pavement structure are same entire alignment	

4.2 Specifications

Design standard, construction and acceptance standard in accordance with list of standards approved by the Ministry of Transport in Decision No. 362/QĐ-BGTVT dated 20th February 2009 and No. 727/QĐ-BGTVT dated 6th April 2012.

5 BRIDGE DESIGN

5.1 Location

Bridge location is same as location of approved basic design in Decision 2656/QĐ-BGTVTdated 10th September 2010 of MOT.

5.2 Typical cross section

Table 5.2 Cross sectional elements

Cross Section Elements	Mark	Initial Stage			Ultimate Stage		
		Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median width	m	1	1.50	1.50	1	1.50	1.50
Marginal Strip with (Inner)	S	2	0.75	1.50	2	0.50	1.00
Travelled way width	B	4	3.75	15.00	6	3.50	21.00
Shoulder(Emergency lane)	L	2	3.00	6.00	-	-	-
Marginal Strip with (Outer)	S	2	0.50	1.00	2	0.75	1.50
Parapet width	p	2	0.50	1.00	2	0.50	1.00
Total (L+B+S+m+p)				**26.00**			**26.00**

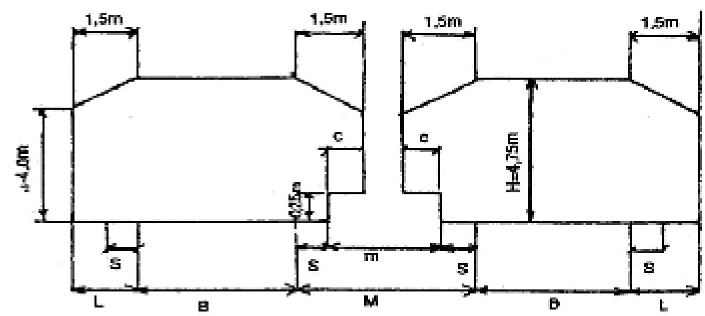


Figure 5.2 Lateral and Vertical Clearances in TCVN5729-1997

5.3 Superstructure

5.3.1 Span Arrangement:

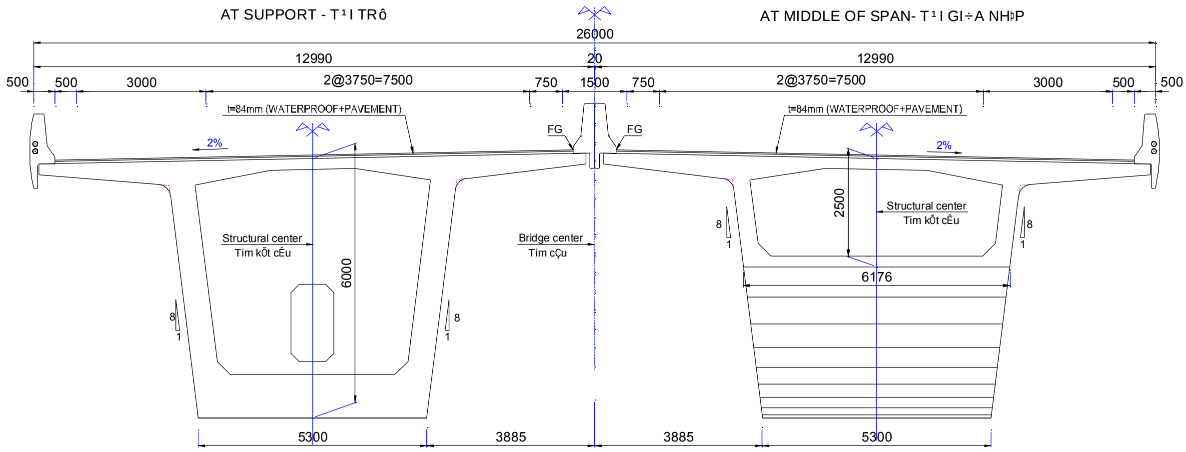
Spans arrangement was approvaled in Basic design stage as follow:

(39.15m+8@40m+39.15m)+ (65m+5@100m+65m), (including 16 spans)

Bridge length L_c=1044.8m (to end of abutment wall).

5.3.2Main Bridge (Box Girder):

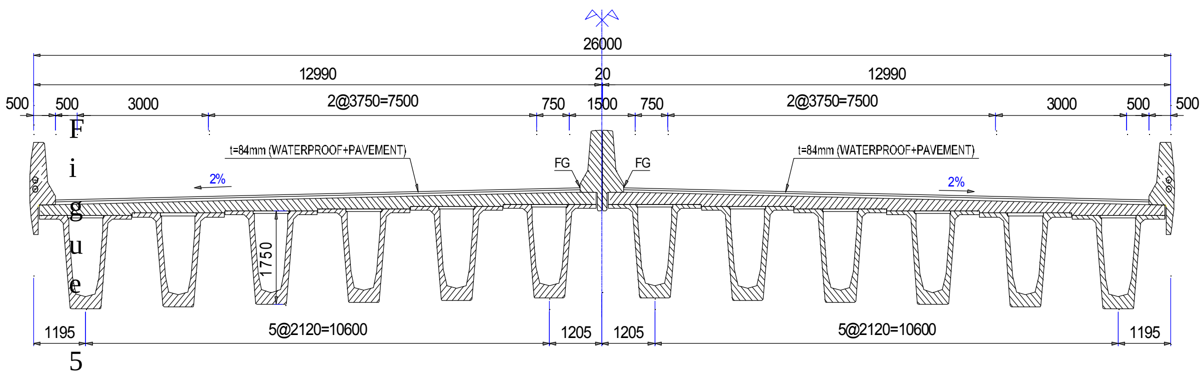
- Type of Bridge :7- span continuous prestressd concrete with one box girder.
- Girder Height : 2.5m - 6.0m
- Longitudinal Tendon: 19S15.2mm. Duct for tendon is provided as a steel duct ϕ100/107mm.
- Transvers Tendon: 3S15.2mm. Duct for tendon is provided as a flad steel duct (20x75)mm.
- Concrete Class:45Mpa.
- Construction Method :Free Cantilever Erection



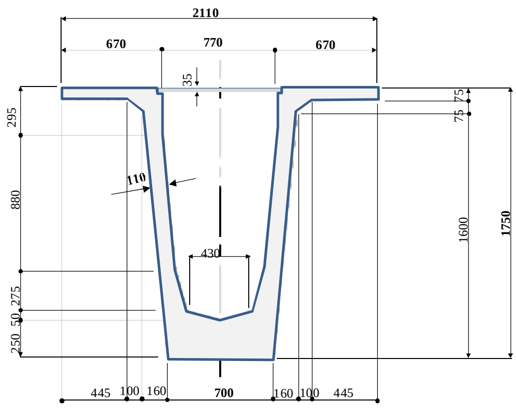
Figue 5.3.2 - Typicall cross section at Main Bridge

5.3.3 Approach Bridge (Super T Girder)

- Type of Bridge :Super T Girder
- Cross section: U-Type, Girder height :1.75m
- Longitudinal Tendon: 15.2mm (Pretension Method)
- Concrete Class:
  - Girder:50Mpa
  - Crossing beam and bridge deck :35MPa
  - Casting plank (3.5cm thick):30MPA
- Construction Method:Girder Lifting Equipment Method
- Number of girder for 1-span:12nos.



Figue 5.3.3.1 - Typicall cross section at Approach Bridge



Figue 5.3.3.2 - Typicall cross section of Super T Girder

5.3.4 Pavement:

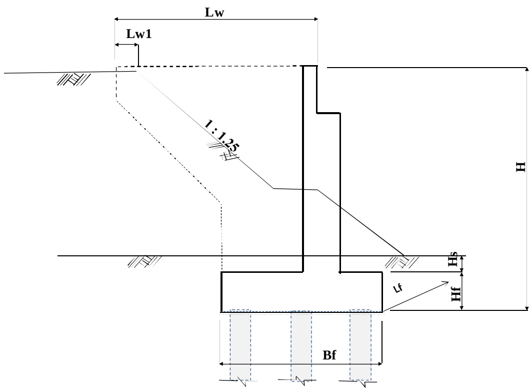
- Ø Bridge surface 8cm thick (Anti-skid asphalt concrete 3cm and fine asphalt concrete 5cm).
  - + Anti-skid Asphalt concrete 3cm.
  - + Tack coat 0.5kg/m^2.
  - + Asphalt concrete 5cm.
  - + Tack coat 0.5kg/m^2.
- Ø Waterproofing layer
- Ø Transversal gradient of main bridge deck is formed by transversal gradient of box girder.
- Ø Transversal gradient of approach deck is formed by transversal gradient of pier cap.

5.4 Substructure

5.4.1 Abutment:

Reverse-T-Shape Abutment in 30MPa RC (reinforced concrete). Abutment foundation includes 12 bored piles in 30MPa RC with D1.5m diameter; assumed length is L_{dk}=50.0m at abutment A1 and L_{dk}=62.0m at abutment A2.

The area behind abutment is filled with tightly compacted granular material of K98 between 2 wing walls; quater-abutment cone is filled with tightly compacted soil of K95; slope is stablized with mortar stonework of 10MPa with 30cm thickness; cutoff dike by mortar stonework.



Figue 5.4.1 – General view of Abutment

5.4.2 Approach Slab:

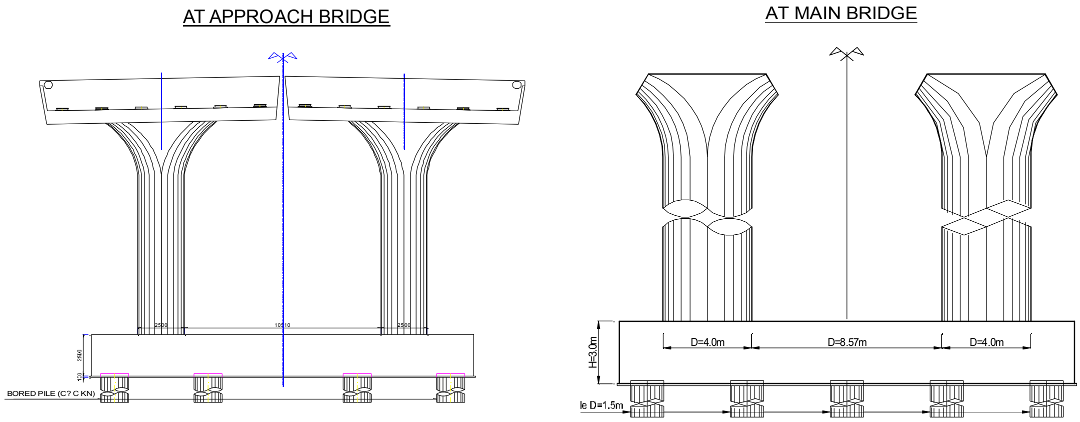
Approacch Slab is made of 25MPa concrete with 6m length ,which is placed on bedding mortar with 10cm thickness.

5.4.3 Pier:

Cylindrical- Pier in cast-in-place 30MPa RC. Bored pile foundation has diameter D=1.5m and assumed length L_{dk}=54.0~64.0m, detail in Table 5.4.3

Table 5.4.3 The Length of Pile at foundation

Location	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Number of pile	8	8	8	8	8	8	8	8	8	10	18	18	22	22	20	18
Length of pile (m)	54	54	58	58	58	62	62	62	62	62	62	64	60	56	54	60



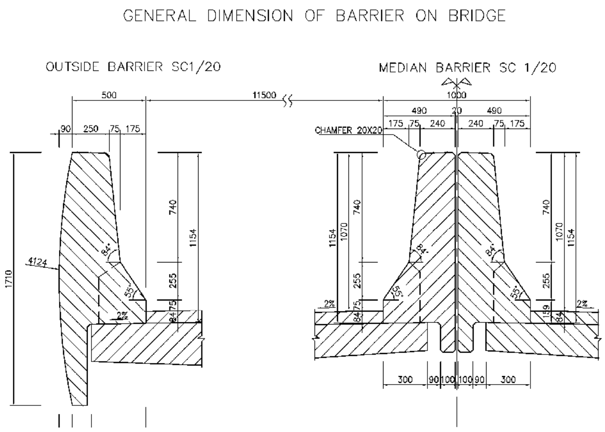
Figue 5.4.3 – General view of Pier

** Note: The piles length only assumed, the final length will be determined when checking at site.*

5.5 Miscellaneous.

5.5.1Traffic Parapet:

Design standard: using the standard 22 TCN 272-05 (AASHTO 1998) and updating some requirements about test level, height of barrier in accordance with the standard AASHTO LRFD 2007 (because it is updated in the standard AASHTO LRFD 2007 after some tests of actual truck collisionin some states of America).



Figue 5.5.1 – Detailed Dimension of Parapet

Selection of test level and height of traffic Parapet:Containment level of barrier is selected basing on type of road, heavy truck traffic volume and site condition. For expressway, the containment level is level 4 (text level 4–minimum height is 810 mm excluding the pavement height).However, in accordance with the Article 13.7.2 of standard AASHTO LRFD 2007 and Article 10.2.4.9 of Roadside design manual and the traffic deman forecast of CPCS report, for expressway, heavy truck traffic volume is greater than 3000 trucks per day, the containment level is selected as level 5 (Text level 5 - Minimum parapet height is 1070 mm excluding pavement height). (Data of heavy truck traffic volume is taken in 2025 from Annex B: Traffic forecasting repost: low case – toll VND 800/Km –with NH1 widening from 2023 in the CPCS report).

Selection of Parapet shape: New Jersey barrier type (NJ-shape) was developed for ages by the Institute of New Jersey State. This Parapet was tested and popular used in US. The shape of proposed parapet is approximate to shape of NJ parapet (about slope, angle of slope-face, and base parapet height, etc.). Shape and basic size of parapet are recommended to refer abow drawings.

Parapet is precast segment type made of 25MPa concrete with 3m length each

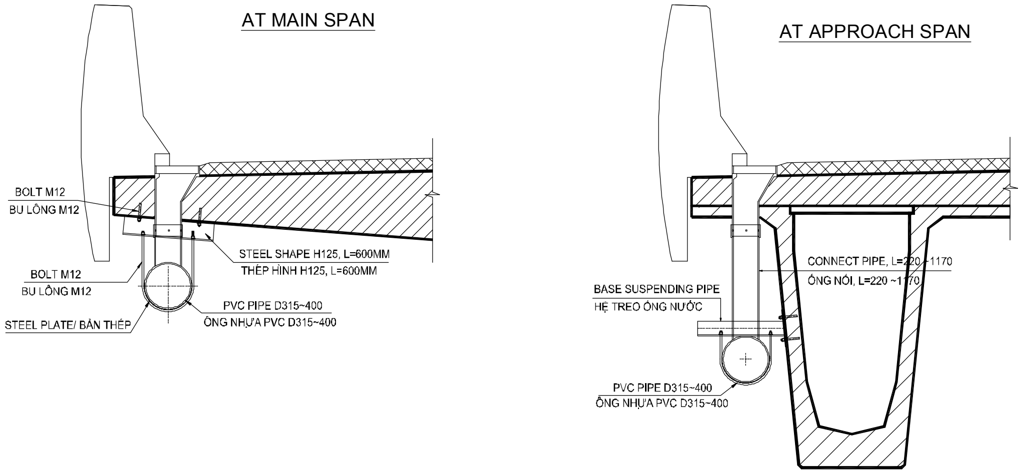
5.5.2 Drainage system:

- **Ø** Design Concept: water from the gutter inlet of the major river bridge is not allowed to drain directly into the river since the spill of fuel and chemicals into the main river by the traffic accident must be avoided. This requirement was previously mentioned in Section 5.4.2.3 of the Supplemental EIA Report and was approved by MONRE in Decision No. 2046/DQ-BTNMT, dated October 29, 2010.
- **Ø** Drainage System:
  - + Cast iron catch with dimension 400x300mm is placed at inner edge of parapet outside bridge in every 10m.

+ Water from catch pit flows through the pipes of PVC D=315~400mm to the catch basin located near the abutment. This catch basin is named as “Ecosystem infiltration basin”or”EIB”.

+ Capacity of EIB is pto be about 50m^3 with reinforced concrete structure which is similar to capacity of the biggest current chemical-carrying vehicle.

+ See to Calcculation Sheet in detail.

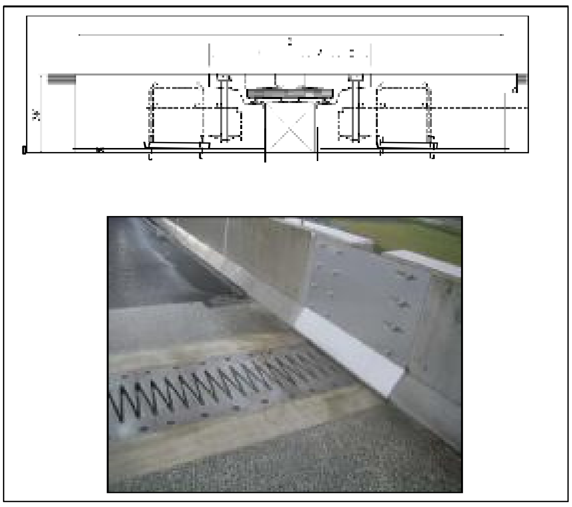


Figue 5.5.2 – Drainage System

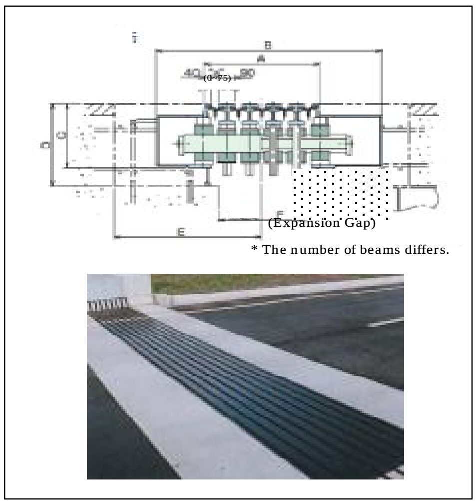
5.5.3 Expansion joint:

- **Ø** Finger -typed joint : Abutment A1 and Pier P5.
- **Ø** Modular-type joint: Abutment A2 and Pier P10 (for large displacement).

Finger Type Expansion Joint on the A1 Abutment and P5 Pier



Modular type Expansion on the A2 Abutment and P10 Pier



Figue 5.5.3 – Expansion Joint images

5.5.4 Support condition:

Support Condition of Ky lam Bridge is shown in Table 5.5.4.1 and Table 5.5.4.2

Table 5.5.4.1 Suport Condition

Loacation	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	A2
Suport	P	E	E	E	E	E	E	E	E	E	P	P	P	R	R	P	P	P

E: Elastomeric
P: Pot Bearing
R:Rigit Frame

Table 5.5.4.2 Dimension of Bearing

Section	Approach bridge (Super T)			Main Bridge (Box Girder)			
Location	P2, P3, P4, P6, P7, P8	P1, P5, P9	A1, P10	P11(e), P12(e), P15(e), P16(e)	P11(i), P12(i), P15(i), P16(i)	P10(e), A2(e)	P10 (i), A2(i)
Type	Type 1	Type 2	Type 3	Type 1	Type 2	Type 1a	Type 2a
	Elastomeric bearing		Pot Bearing	Pot Bearing			
Size (mm)	350x600x84	350x600x141	455x540x82	1360x1660x311	1130x1530x331	480x790x128	500x810x143
Capacity(kN)	1,600	1,600	2,000	20,000	20,000	5,000	500

(e): Exterior Bearing
(i): Interior Bearing

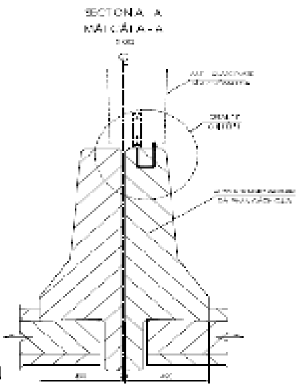
5.5.5 Anti-glare Plate

Anti-Glare Plates are proposed to be installed for the project in accordance with the NEXCO standards

Anti-glare Plates are arranged along the length of the route (and bridges) on top of the median wall. The distance between the anti-glare plates, structural and materials of anti-glare plates will be uniform throughout the project (in other packages).

In package 3A, only bolts is embedded on top of the median parapet for setting anti-glare plates with every 4m pitch.

Anti –glare Plate image is shown in Figure 5.5.5.



Figı

5.5.6 Lighting system on Bridge

- Ø Package 3A includes only:
- The lighting - post bases by reinforced concrete 25MPa in casting place along the outside of parapet with an average distance of 40m/ 1st position.
- The man hole for technical inspection and wire connectors at both sides of the bridge.
- The tube is available in the parapet for the wiring and communication line.
- Ø Communication line system, wiring, lamp and other related equipment will be includes in different packages.

5.5.7 Bridge history plate

There are no regulation for the bridge history plate in Vietnam. Reference Japanese design standard, the scope of the project proposed to apply bridge history plate for 4 major bridges (Kỳ Lam bridge, Chiem Son bridge, Tra Bong and Tra Khuc bridge).

Bridge history plate have dimension (70x45) cm 1.5cm thick by bronze shall be install in the surface of the parapet on the abutment wing wall, in which inscribe the Bridge name, Client, Consultants, Contractor and complete date.

5.5.8 Regulation of traffic signals

Bridge name plaques, waterway traffic signs, lanepainting work, etc. should be complied with regulations in "Regulation of traffic signal 22TCN237-01".

5.6 Revetment/river bed protection

5.6.1 The necessary

The hydraulic analysis of the Thu Bon River in the vicinity of the Ky Lam Bridge using 1% probability flood discharge of 10953 m3/sec confirmed the high potential for scour due to contraction and long-term degradation and local scouring at the abutments, piers and the river banks. The general scour potential is nearly 0.4m in the river channel. The local scour potential ranged from about 2.60m to 8.10m for the piers. The local scour is 0.15m for the left abutment and 0.65m for the right abutment.

5.6.2 River bed protection (at piers location)

The unstable river bed condition due to high volume of movement of the cohesionless sand river bed material suggests that providing river bed and pier scour protection works may not be technically feasible nor economically viable considering the nearly 1 kilometer channel width. Furthermore, the 2 to 3m pier embedment and the 60m length of the piles supporting the piers is much greater than the computed scour depth.

5.6.3 Revetment protection (at Abutments location and river bank)

It is recommended that the left and right abutments shall be protected with grouted riprap extending from 1m below the existing ground to the top of the abutment. Details of the protection works are provided in the drawings.

It is recommended that the left bank shall be provided with partially grouted riprap revetment from the top of the bank down to the river bed and extending within the right-of-way of the project. Details of the protection works are provided in the drawings.

It is recommended that the right bank shall be provided with gabion mattress revetment from the top of the bank down to at least 1.50m below the river bed and extending within the right-of-way limits of the project. Details of the protection works are provided in the drawings.

5.6.4 Recommend for existing bank protection

Because of the perceived critical scouring in the right channel near the right bank, it is further recommended that an adjunct project to extend the right bank revetment at least 400m upstream and 200m downstream of Ky Lam bridge be undertaken for better protection of the right bank and right bridge abutment

6 HIGHWAY DESIGN

6.1.1 Geometric Design Standards

According to the Decision No.362/QD-BGTVT regarding “Standard frame applied for Da Nang – Quang Ngai expressway” dated 20 February 2009, the Vietnamese geometric design standards to be applied for the project are as follows:

- Expressway design standards TCVN 5729-97;
- Highway design standards TCVN 4054-05;
- Standard for designing highway 22TCN 273-2001;

Where no provisions exist in those standards, the relevant standards of AASHTO (A Policy on Geometric Design of Highways and Streets, 2011) or JRSO (Japan Road Structure Ordinance, 2004) to be referred.

6.1.2 Design Vehicles

Design vehicle is not clearly mentioned in the F/S. Dimension of Semi-trailer stipulated in TCVN4054 as shown in Table 6.1 shall be applied to the design.

Table 6.1 Design Vehicles

Type	Length (m)	Width (m)	Height (m)	Front Overhang (m)	Rear Overhang (m)	Wheel base (m)
Car	6.00	1.80	2.00	0.80	1.40	3.80
Truck	12.00	2.50	4.00	1.50	4.00	6.50
Semi-trailer	16.50	2.50	4.00	1.20	2.00	4.00 – 8.80

Source: TCVN4054-2005

6.1.3 Road Classification and Design Speed

Topographic features of the Da Nang – Quang Ngai expressway is generally flat with partial rolling sections. Expressway classfication Type A and design speed of 120km/h are applied to the expressway mainline in accordance with TCVN 5729-1997.

Class A is applied to frontage road in accordance with No. 315 /QD-BGTVT.

6.1.4 Required Lateral and Vertical Clearances

TCVN5729-1997 is applied to lateral and vertical clearances on thruway and TCVN 4054-2005 is applied to lateral and vertical clearances on crossing roads and frontage roads which is given class I to VI.

(1) TCVN5729-1997

The lateral and vertical clearances for mound type median stipulated in TCVN5729-1997 are given in Figure 6.1.3(1) A 1.5m width is shown as hunch width at the top of envelop of corridor in the figure. However, dimension of hunch should be flexible because that the hunch is outside of travelled way space.

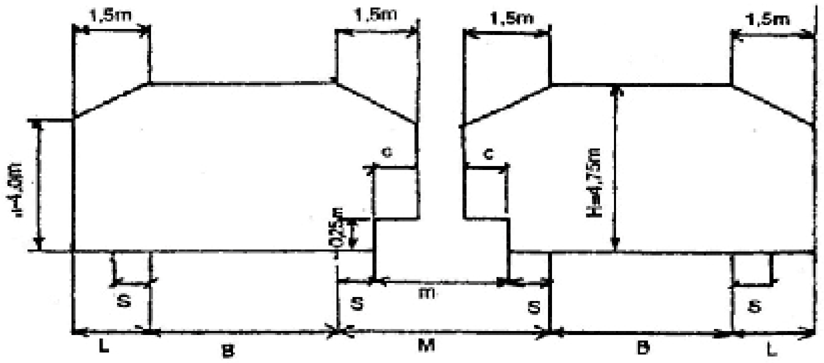


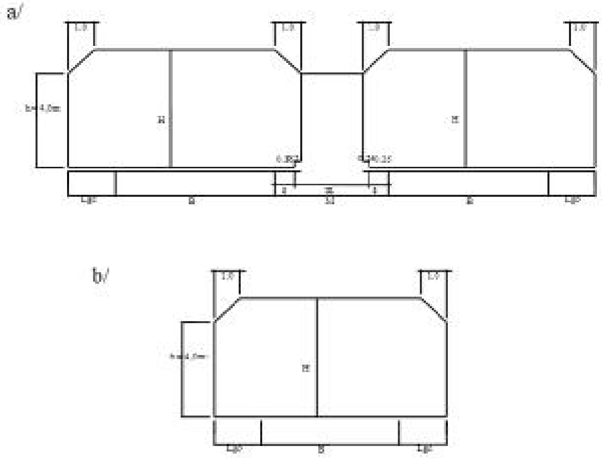
Figure 6.1.3(1) Lateral and Vertical Clearances in TCVN5729-1997

Where, (applied values)

m – median width (1.5m)
S – median marginal strip width (0.75m)
B – traveled way width (7.5m - initial stage, 11.25 -ultimate stage)
L – paved shoulder width (3.0m, the hunch width should be same as this value)
C – 0.3 m for Grade 120

(2) TCVN4054-2005

The lateral and vertical clearances stipulated in TCVN4054-2005 are given in Figure 6.1.3(2). A 1.0m width is shown as hunch width at the top of envelop of corridor in the figure. However, dimension of hunch should be flexible because that the hunch is outside of travelled way space.



Note: a- Highways of Vtk ≥ 80 km/h with median, b- All types of highway without median;

Figure 6.1.3(2) Lateral and Vertical Clearances in TCVN4054-2005

Where,

B - Width of traveled way;
Lgc - width of stabilized shoulder part;
m - Separated part;
s - Safety part (stabilized);
M - width of separator;
M, m, s- minimum values
H - Clearance height from the highest point of traveled lane (the height does not take into account of the reserved height for pavement raising when repairing or improvement);
h - Clearance height at the edge of stabilized shoulder
H = 4.75 m h = 4.00 m for highway class I, II, III
H = 4.50 m h = 4.00 m for remaining highway classes

6.1.5 Decision 315/QD-BGTVT

In consideration of clearance height specified in Decision 315/QD-BGTVT for each classification, lateral and vertical clearance of AH class follows criteria in TCVN4054-2005.

As for road classifications of A to C, lateral and vertical clearance is not specified in Decision 315/QD-BGTVT.

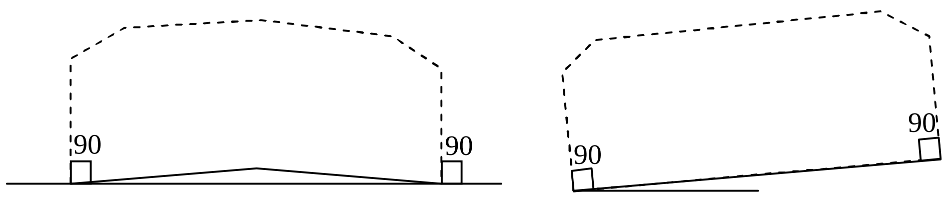
6.1.6 Setting of Lateral and Vertical Clearance

As for setting of the lateral and vertical clearance lines on level section with crossfall and superelevation section, there is no stipulation in Vietnamese standards.

With reference to JRSO Japan, the following standards are developed:

Ceiling line of the envelope is parallel with road surface.

Vertical edge lines are perpendicular to road surface. In case (a) normal cross fall, the vertical edge lines are plumb line, in case (b) super-elevated cross fall, the vertical edge lines are perpendicular to road surface shown in Figure 6.1.5. In case, the super-elevated value is smaller than the normal crossfall, which is 2%, plumb line is applied.



(a) Typical Crossfall Section (i=2%) (b) Superelevation Section

Figure 6.1.5 Setting of Lateral and Vertical Clearances Lines

6.1.7 Geometric Design Criteria for Thruway

Summary of geometric design criteria to be applied for the PKG3A for thruway with design speed of 120km/h is given in Table 6.1.6.

Table 6.1.6 Geometric Design Criteria for Thruway (Initial Stage)

		Design Elements	Type/Value	Remarks	Reference
1		Expressway Classification	Grade 120	Type A	TCVN5729
2		Terrain	Flat		TCVN5729
3		Design Speed (km/h)	120		TCVN5729
4	Cross-Sectional Elements	Basic Lane Width (m)	3.75		TCVN5729
		Number of Lanes in each Traveled Way	2		F/S
		Number of Traveled Way	2		F/S
		Formation Width (m)	25.5		F/S
		Traveled Way Width(m)	2 x 7.5		TCVN5729
		Outer Shoulder Paved Width (m)	2 x 3.0		TCVN5729
		Outer Shoulder Earthen Width (m)	2 x 0.75		F/S
		Median Width (m)	1.5		F/S
		Median Marginal Strip (m)	2 x 0.75		TCVN5729
		Crossfall of Roadway (%)	2.0		TCVN5729
		Slope of Earthworks			
		Fill	V : H = 1:2.0		F/S
		Cut (soil)	V : H = 1:1.0		F/S
		Cut (stone Class 4)	V : H = 1:0.75		F/S
5	Sight Dist.	Stopping Sight Distance (m)	230		TCVN5729
		Driver's Eye Height (m)	1.2		TCVN5729
		Height of Object (m)	0.3		TCVN5729
6	Horizontal Alignment	Horizontal Curve			
		Absolute Minimum Radius of Horizontal Curve	650		TCVN5729
		Desirable Minimum Radius of Horizontal Curve	1000		TCVN5729
		Minimum Radius without Superelevation (m)	4000		TCVN5729
		Superelevation (Se)			TCVN5729
		Maximum Se for Absolute Minimum Radius (%)	7.0		TCVN5729
		Maximum Se for Desirable Minimum Radius (%)	5.0		TCVN5729
		Transition Curve			
		Minimum Length for Absolute Minimum Radius	210		TCVN5729
		Minimum Length for Desirable Minimum Radius	150		TCVN5729
		Minimum Length for Radius of 1125 m (m)	125		TCVN5729
		Minimum Length for Radius larger than 1125 m	R/9		TCVN5729
7	Vertical Alignment	Vertical Gradient			
		Maximum Gradient			
		Maximum Grade-Up (%)	4.0		TCVN5729
		Maximum Grade-Down (%)	5.5		TCVN5729
		Critical Length for Maximum Grade of 4% (m)	600		
		Minimum Gradient			
		Minimum Grade for Cut Section (%)	0.5		TCVN5729
		Minimum Grade for Transition Section with	1.0		TCVN5729
		Minimum Grade for Tunnel Section (%)	0.3		TCVN5729
		Minimum Length of Grade (m)	300		TCVN5729
		Vertical Curve			
		Minimum Length of Vertical Curve (m)	100		TCVN5729
		Minimum Radius of Crest Curve (m)			
		Absolute Minimum Radius (m)	12000		TCVN5729
		Desirable Minimum Radius (m)	17000		TCVN5729
		Desirable Radius (m)	20000		TCVN5729
		Minimum Radius of Sag Curve (m)			
		Absolute Minimum Radius (m)	5000		TCVN5729
		Desirable Minimum Radius (m)	6000		TCVN5729
		Desirable Radius (m)	12000		TCVN5729
8		Lateral Clearance (m)	Traveled width		TCVN5729
		Vertical Clearance (m)	4.75		TCVN5729

6.2 Typical Cross Sections

The cross section elements for PKG3A are proposed as shown in Table 6.2.

Table 6.2 Proposed Cross Section Elements in the Basic Design

Cross Section Elements	D/D (Proposal)											
	Initial Stage						Ultimate Stage					
	Earthwork Section			Bridge Section			Earthwork Section			Bridge Section		
	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	1.50	1.50	1	1.50	1.50	1	1.50	1.50	1	1.50	1.50
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50
Marginal Strip (Inner) Long Bridge (PC-Box)										2	0.50	1.00
Traveled Way	4	3.75	15.00	4	3.75	15.00	6	3.75	22.50	6	3.75	22.50
Traveled Way Long Bridge (PC-Box)										6	***3.50***	21.00
Paved Shoulder include Marginal Strip (Outer)	2	3.00	6.00	2	3.00	6.00	2	3.00	6.00	2	3.00	6.00
Paved Shoulder include Marginal Strip (Outer) Long Bridge (PC-Box)										2	0.50	1.00
Earthen Shoulder	2	0.75	1.50				2	0.75	1.50			
Parapet, Service Space				2	0.75	1.50				2	0.75	1.50
Parapet, Service Space Long Bridge (PC-Box)				2	1.00	2.00				2	0.75	1.50
Total			25.50			25.50			33.00			33.00
					PC-Box	26.00					PC-Box	26.00

Note: Underlined values are proposed values by the Consultant

Total width of 25.5m for general section and 26.0m for PC-Box Bridge section are proposed in initial stage and the boundaries for land acquisition are 10m outer side from edge of embankment slopes on the general section of the expressway.

Proposed typical cross sections of the road embankment are shown in Figure 6.2 (a, b, c, d).

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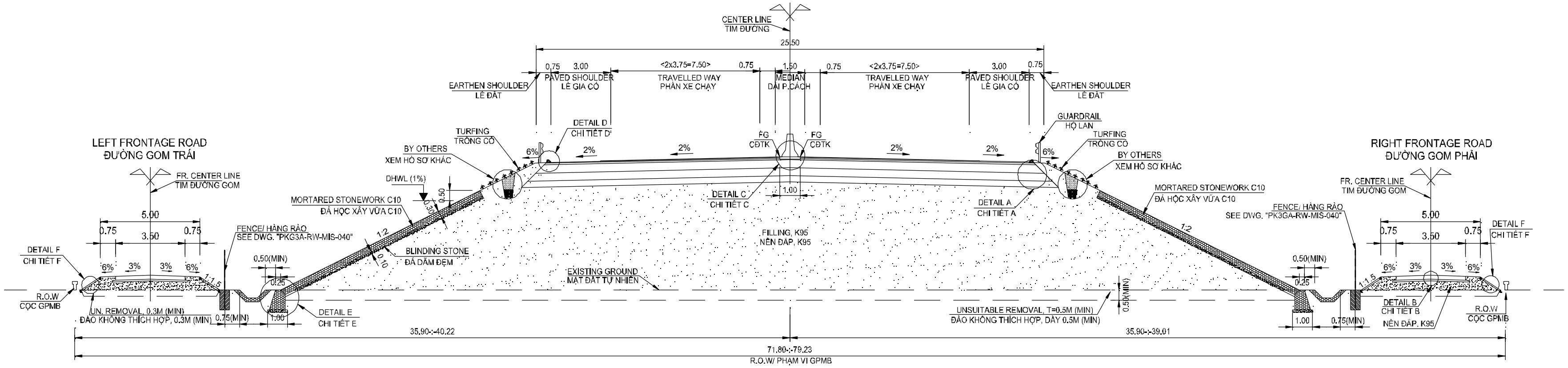


Figure 6.2(a) Typical Cross Section of Embankment with Frontage Road (KM16+880-KM16+935.40)

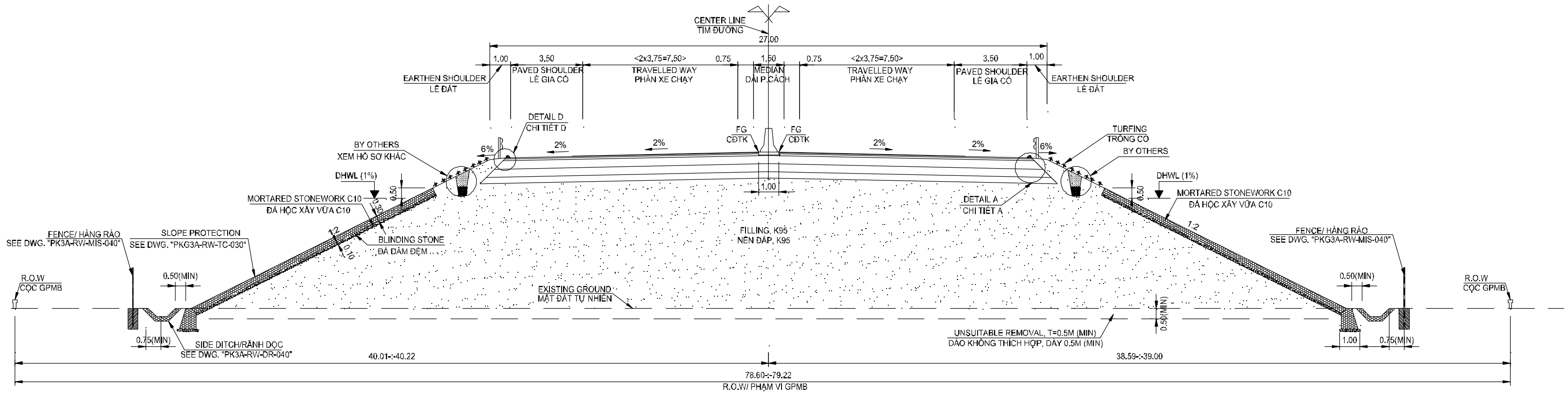


Figure 6.2 (b) Typical Cross Section of Bridge Approach (KM16+970.4-KM16+980.4)

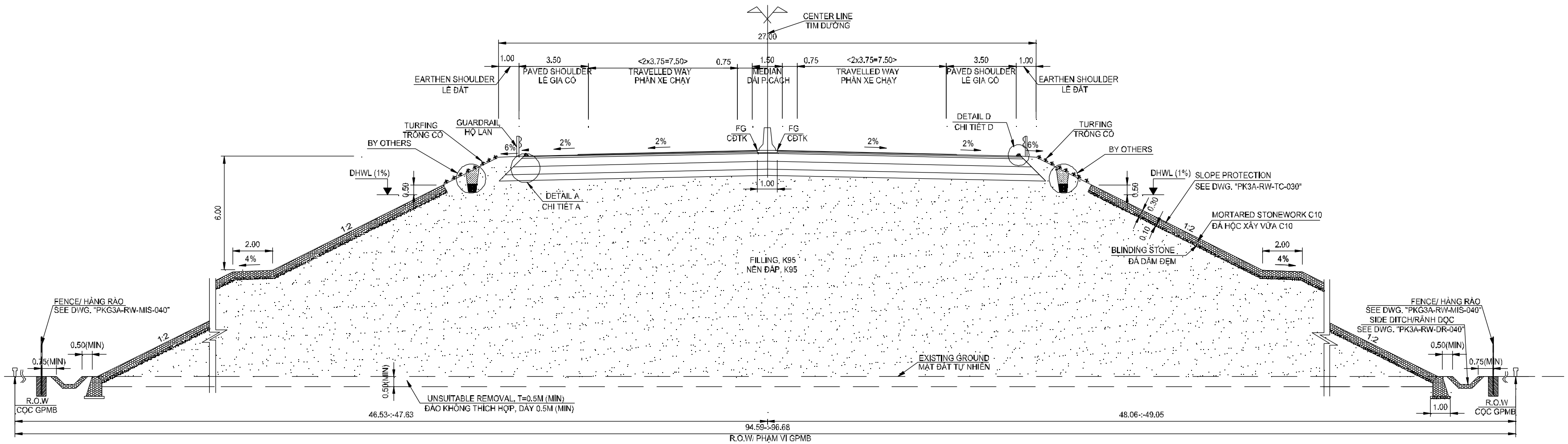


Figure 6.2 (c) Typical Cross Section of Bridge Approach (KM18+025.20-KM18+035.20)

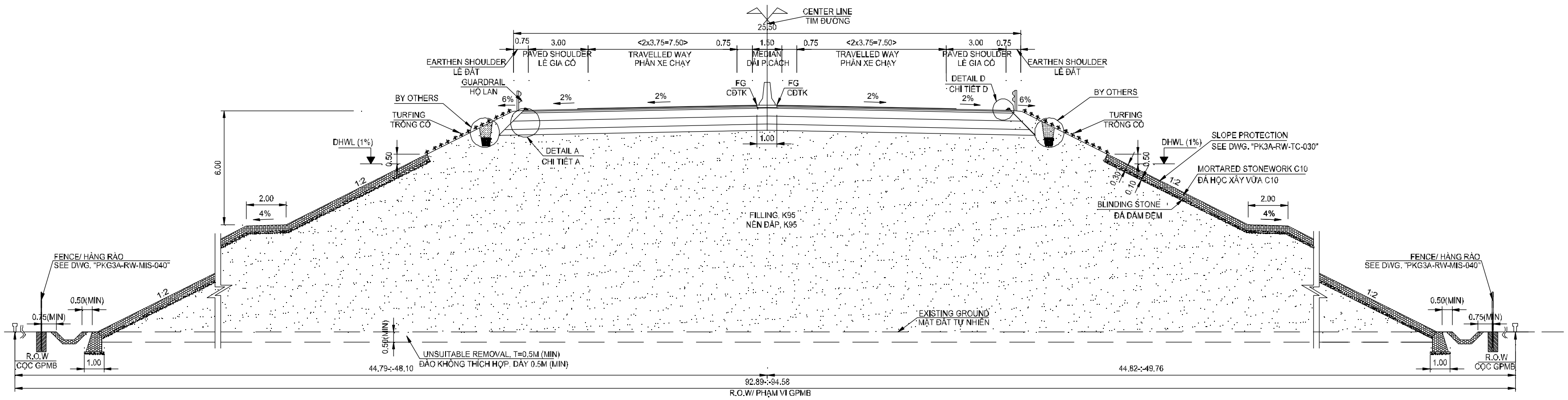


Figure 6.2 (d) Typical Cross Section of Embankment without Frontage Road (KM18+070.20-KM18+100)

6.3 Geometric Design

6.3.1 Horizontal Alignment

Alignment of PKG3A section starts from KM16+880 at paved village road located about 140m north from left side river bank of Thu Bon River in Dien Tho commune of Dien Ban district.

The section ends at KM18+100 near paved village road where it is about 180m south from right side river bank of Thu Bon River in Dien Quang commune of Dien Ban district.

The horizontal alignment design of the PKG3A has taken into account the plan of the Ky Lam Bridge. Thu Bon River and the existing railway bridge on planning of Ky Lam Bridge are selected as horizontal design controls. The horizontal alignment for the PKG3A is shown in Table 6.3.1.

Table 6.3.1 Horizontal Alignment

Element	Station	Azimuth	Northing	Easting	Radius	Length	A-parameter
TC	15+851.857		519488.554	1755225.928			
PI-6	16+170.156	1d49m25s	519619.162	1754935.629	20000	636.597	
CT	16+488.454		519740.466	1754641.322			
Start PKG3A	16+880.000		519889.672	1754279.320			
End PKG3A	18+100.000		520354.575	1753151.372			
TS	18+262.891		520416.648	1753000.772			
						220.000	663.325
SC	18+482.891		520496.730	1752795.897			
PI-7	18+781.455	23d24m22s	520616.534	1752515.809	2000	597.128	
CS	19+080.018		520607.138	1752211.320			
						220.000	663.325
ST	19+300.018		520607.297	1751991.349			

6.3.2 Vertical Alignment

Profile elevations at Abutment A1 and Pier P16 are controlled by Design High Wate Level (DHWL) $H_{1\%}$, superstructural high and freeboard with driftwood. There is no other outstanding vertical design control on this section.

The design high water level (1%) at Ky Lam Bridge is 9.2m. The vertical alignment for the PKG3A is shown in Table 6.3.2.

Table 6.3.2 Vertical Alignment

VIP No.	Station	Elevation	Grade-in	Grade-out	VCL	VCR
1	16+898.497	11.882	-0.500%	1.200%	150.0m	8,823.96
2	17+700.000	21.500	1.200%	-1.900%	500.0m	16,129.03
3	18+165.957	12.647	-1.900%		150.0m	6,821.18

6.4 Design of Embankment

Embankment slope is designed with a value of 1:2 (1 vertical to 2 horizontal) when height of embankment is less than 10m. When the height of embankment is greater than 10m, a berm of 2m width is applied at a height of 6m.

6.5 Pavement Design

The designed pavement thickness in PKG3A is given in Figure 6.5. The pavement is designed for Eyc≥200MPa and the total thickness of the pavement is 91cm, including 36cm of aggregate subbase (Type-II), 30cm of aggregate base (Type-I), 10cm of asphalt treated base, 7cm of asphalt concrete binder, 5cm of asphalt concrete surface and 3cm of asphalt concrete anti-skid resistant layers. A minimum of 30cm of subgrade is designed with a compaction degree of 98%.

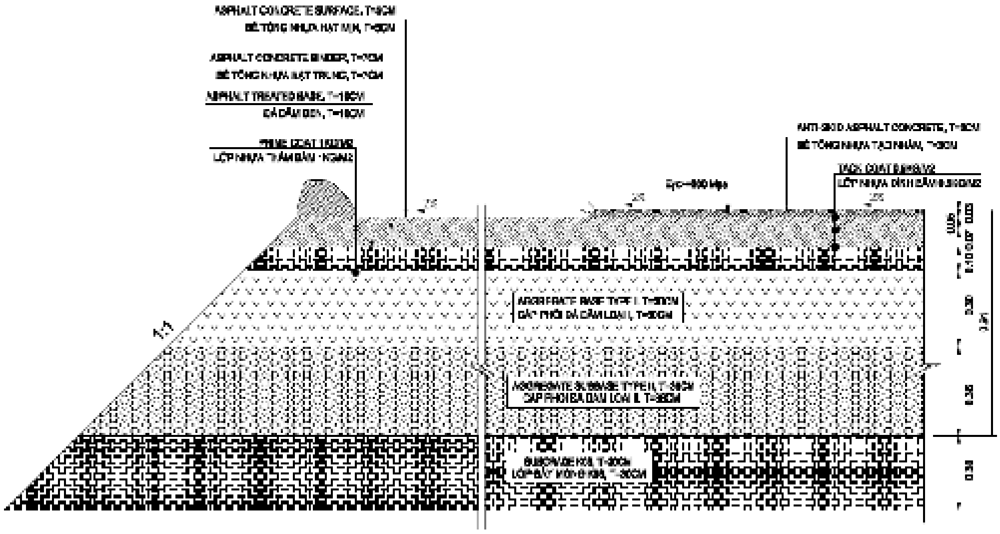


Figure 6.5 Pavement Thickness in PKG 3A

6.6 Drainage Design

6.6.1 Longitudinal Roadside Drainage

Asphalt curb is designed at the roadside (edge of the road) to protect the embankment slopes from erosion (no slope protection is required at normal sections) as shown in Figure 6.6 and discharge water through vertical drains designed at regular intervals, as required from the calculation of rainfall intensity with return period of 25 years (4%). The intervals of vertical drains are calculated for different cross fall (superelevation) and designed profile grades at a particular section. Since the length of road in PKG3A is short, the vertical drains are necessitated in other adjacent construction packages only.

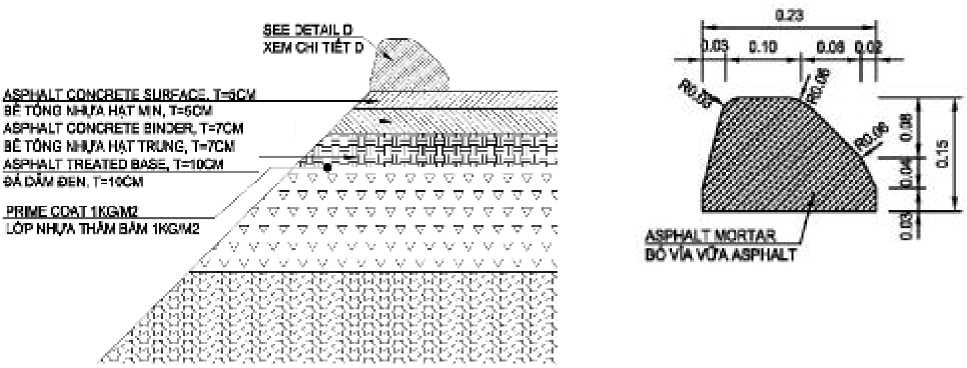


Figure 6.6 Design of Asphalt Curb

6.6.2 Longitudinal Drainage at Toe of Embankment Slopes

Longitudinal trapezium-shaped drainages with mortared stonework (Figure 6.7) are designed at the toe of embankment slopes on both sides of the road and are discharged to the natural stream.

6.7 Design of Slope Protection

In normal embankment, the embankment slopes are protected only by turfing. However, in the bridge approaches, 10m of approach road from the end of the bridge are protected with mortared stonework as shown in Figure 6.7, from top to the toe of embankment slope. Beyond the 10m of approach road, the embankment slopes are protected with mortared stonework to a height determined by 50cm more than the design high water level of 1%.

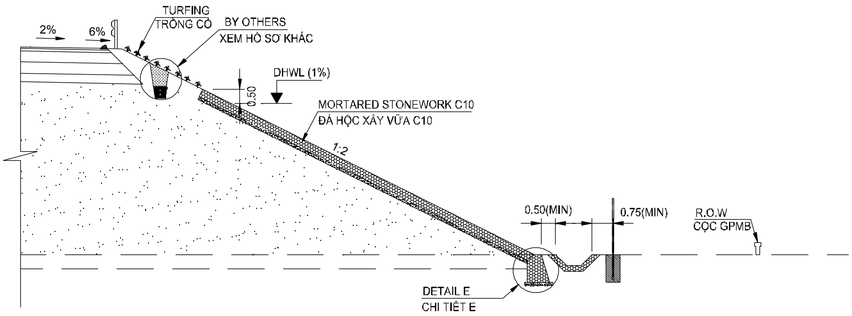


Figure 6.7 Design of Slope Protection in PKG3A

6.8 Design of Frontage Roads

Frontage roads are designed at both sides of Northern approach and East side of Southern approach.The typical cross section of the frontage road is given in Figure 6.8.

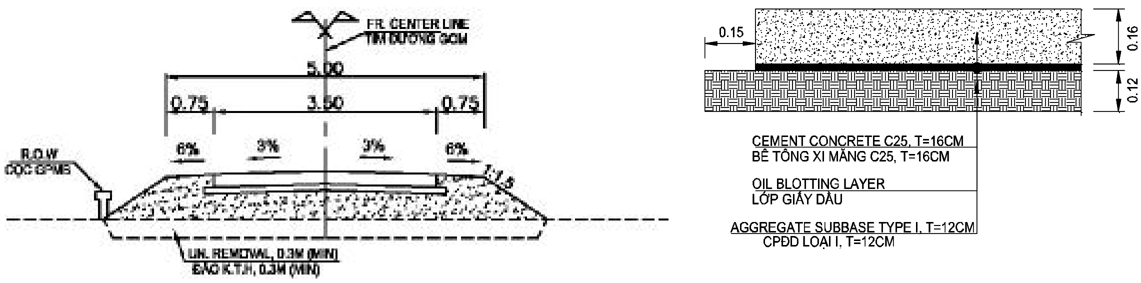


Figure 6.8 Typical Cross Section of Frontage Road

6.9 Slope Stability Analysis

According to the stability analysis results, the safety factor of embankment stability is over 1.2 during construction stage and is over 1.4 during service stage without soil treatment. And the residual settlement were estimated at below 10cm within planned construction period (16months) without soil treatment. Thus the consultant have determined that the soft soil treatment will not be applied for the sections in this package.For detail refer toGeotechnical Design Report.

7 CONSTRUCTION PLAN

7.1 Temporary Works

7.1.1 Temporary Roads

The temporary road is divided into two categories

Ø Category 1: Entrance access road

This road is used in order to connect the construction site with NH1.

The entrance access road for PKG3A are No.3 and No.4.

Table 7-1 Entrance Access Roads for PKG3A

No. of EAR	Length	Existing width	Pavement	Structure
No.3 (TL609)	8,828m	8.0m(6.0m paved)	As paved	Bridge: ,1Culvert: 4
No.4	9,540m	6.0m	As paved	Culvert: 4

Ø Category 2: Site access road

This road is installed in a construction site and used for conveyance of the soil, construction materials, etc.

Figure 7-1 shows temporally Road.

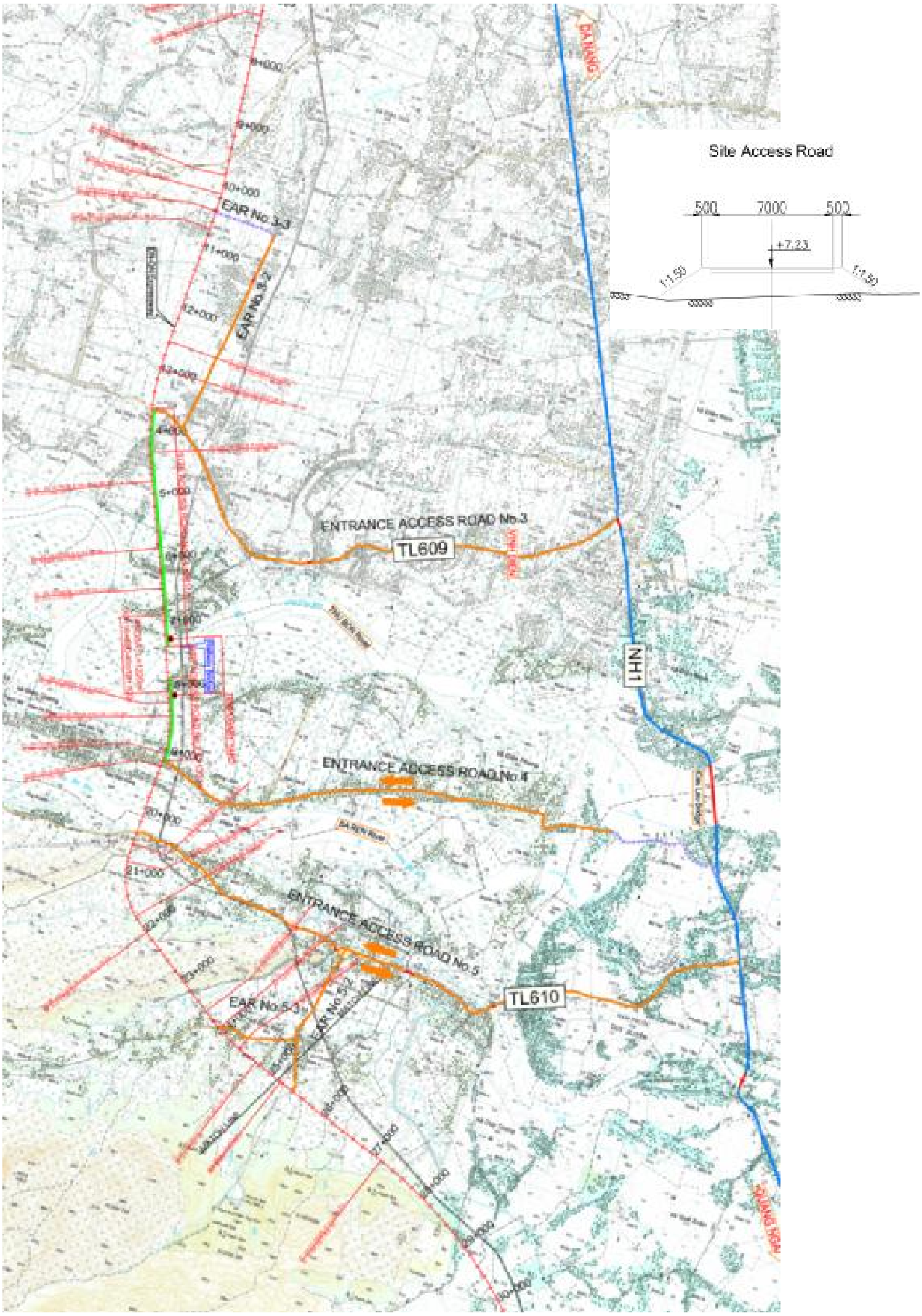


Figure7-1 Temporary Roads

7.1.2 Pier Construction Platform

The pier construction platform is prepared for construction of substructure except P13, P14, and P15.
The structure of a platform is built with embankment so that a bridge pier may be surrounded at 40 m in width.

PLAN of Pier Construction Platform

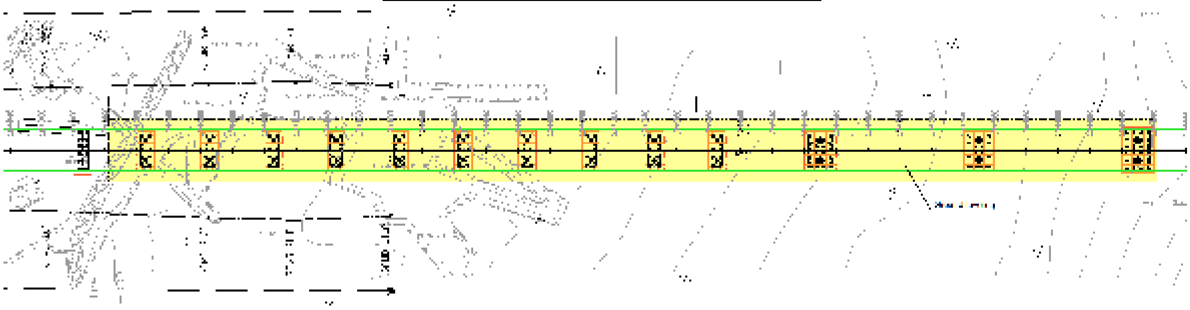


Figure7-2 Pier Construction Platform

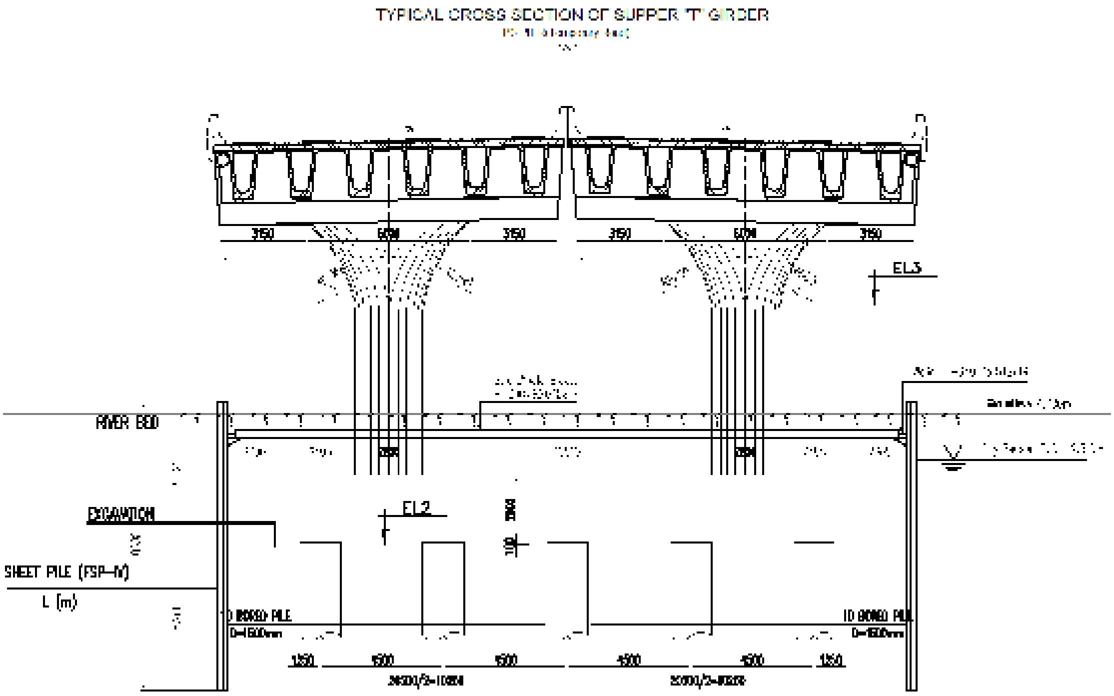
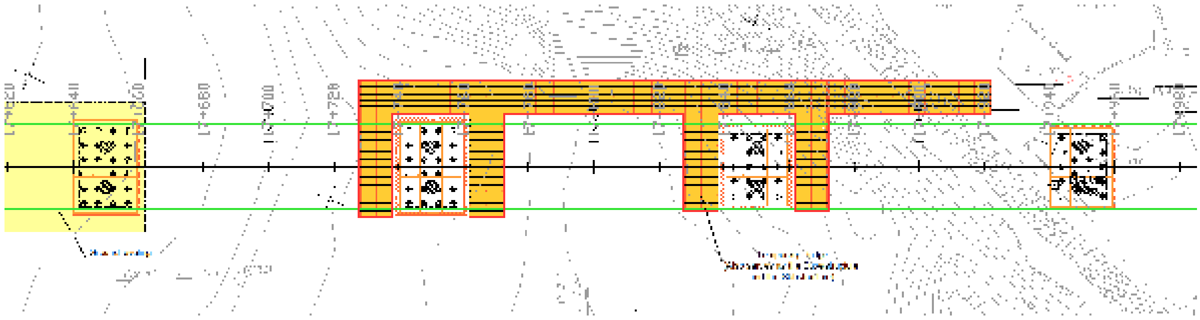
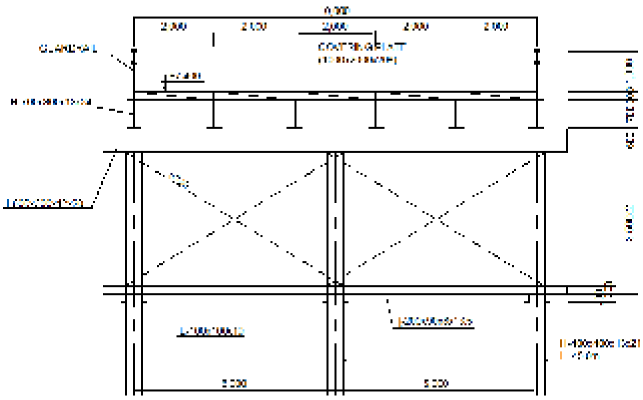


Figure7-3Pier Construction Platform Cross Section

7.1.3 Temporary Bridge

The temporary bridge is installed in deep position of river at P14, and P15.





Temporary bridge length = 196m
Temporary bridge width = 10m
Install area = 3810m2

Figure7-4Temporary Bridge

7.2 Construction Method

7.2.1 Substructure

(1) Cofferdams

Cofferdams shall be constructed with the use of sheet piles to provide support to pier working platforms and to allow dewatering of excavations for pile cap / pier shaft construction. There is considerable local experience in Vietnam of this form of temporary works construction.

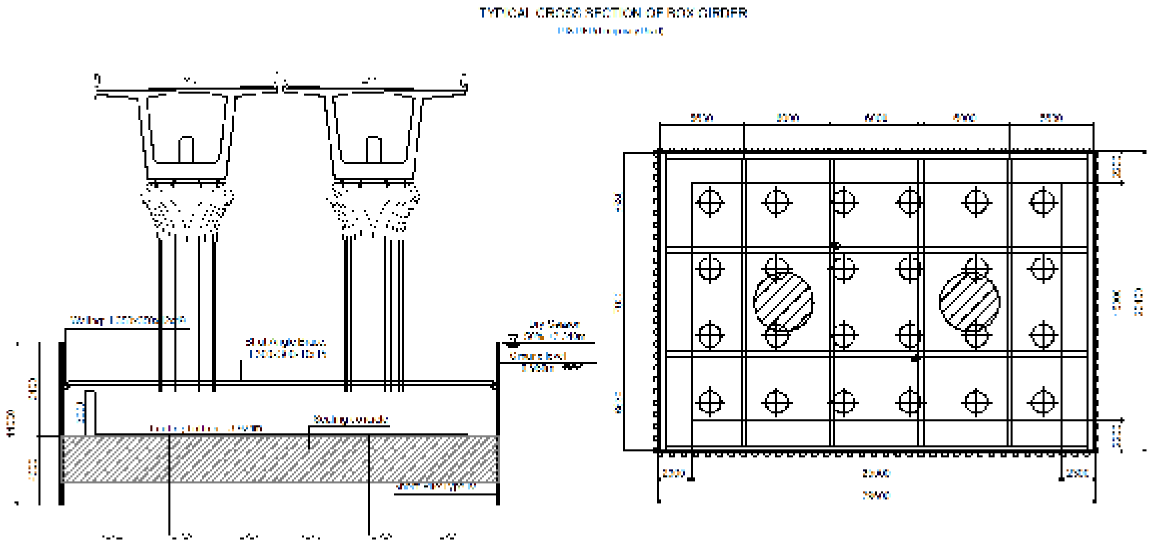


Figure7-5-1　Cofferdoms for Pier Construction(On Land)

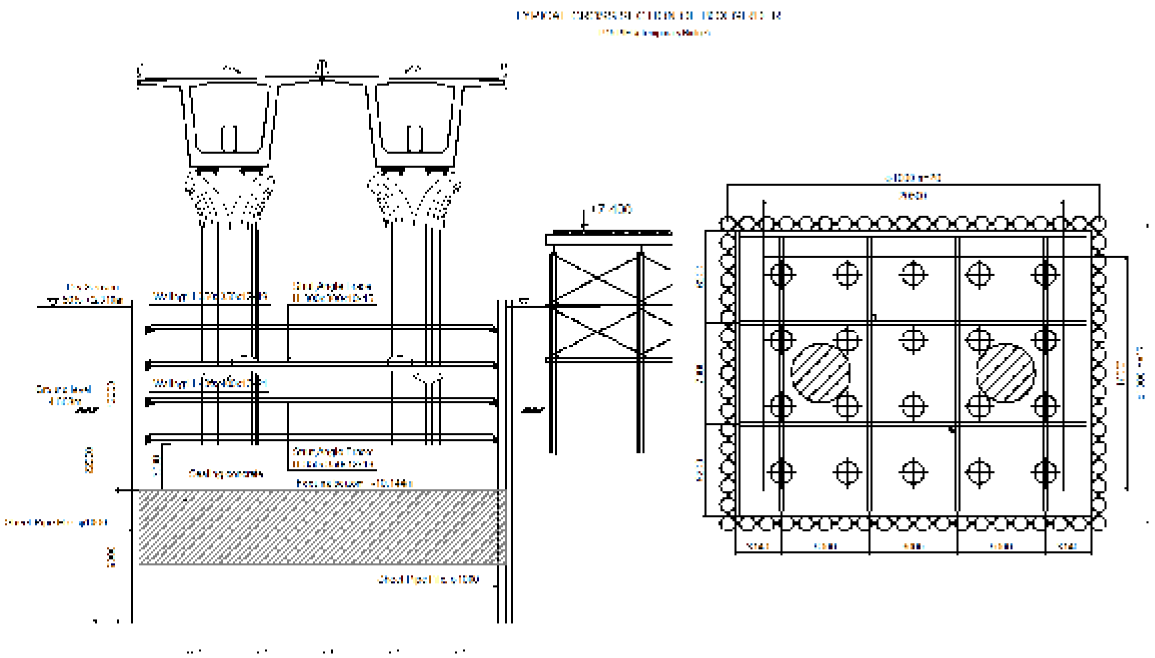


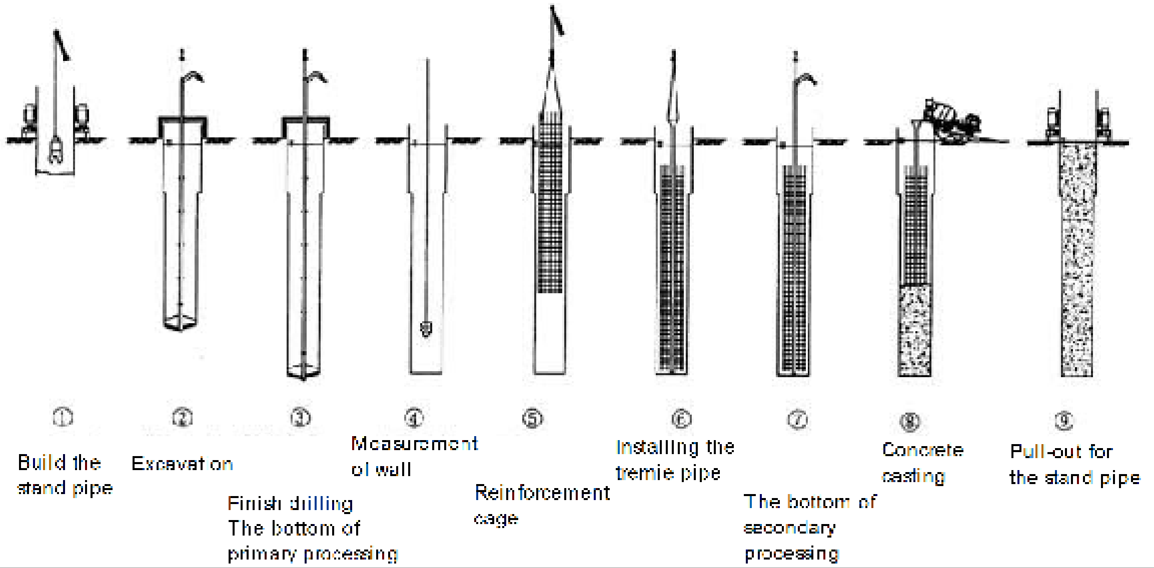
Figure7-6-2　Cofferdoms for Pier Construction(Into the water)

(2) Pile Construction

It is normallyproposed that piles shall be constructed by the Reverse-Circulation Method, Benoto Method, the Earth Drilling method or by boring with a large diameter auger.

Reverse-Circulation Method is suitable method of The Ky lam Bridge as shown in table-1

Figure 7-7 shows Construction Step of Reverse-Circulation Method.



Ø Figure7-7Construction Step of Reverse-Circulation Method

Table 7.2 Applicability of cast-in-place pile method

Applicability of cast-in-place pile method

Method			Benoto Method		Reverse-Circulation Method	Earth Drillng Method	Chicago method
How to protect the hole wall			Casing tube		Stand pipe and Natural Muddy water	Surface casing and Stable liquid	Sheeting material
Standard pile diameter (m)			Rocking	Rotating	0.8～3.0	0.8～3.0	2.0～4.0
			0.8～2.0	0.8～3.0			
Drilling intensity standard (m)			20～40	30～50	30～60	30～60	10～20
Conditions ground	General geology		Possible in most soil. However, in the thick sand layer is sometimes difficult to pull-out of the casing tube. If the artesian head is higher than the ground surface is also impossible construction.		Stone does not pass through the drill pipe construction is impossible..If artesian head is higher than the ground surface is difficult.	Excavation using a stable solution in general. If the artesian head is higher than the ground surface is also impossible construction.	If the soft ground and underground water level is high, the construction is difficult. In addition, the construction of in ground that may ejection of toxic gases and oxygen deficiency is difficult.
	Very soft clay, and humus N≦1		Consider thinning concrete pile near the head, measures.		Note collapse stand pipe and the lower end portion of the casing surface, to its fall.		Suspect for heaving
	Clay, silt soft 1＜N≦2		Suspect for thinning concrete near the pile head.				
	Clay, silt N=3～30		Possible				Possible
	Sand	N=0～30	Suspect for boiling		Possible		
		N=30～	Suspect casing tube for withdrawal				
	Gravel		Possible		Possible	Slightly difficult	Possible
	Cobble(mm)		200～300	Possible	About 150	About 100	
	Boulders		Difficult		Impossible	Impossible	
	Sat red				Possible	Possible	
	Soft rock				Difficult	Impossible	
	Hard rock		Impossible				
	RC structures				Impossible		
	Confirmation of the support layer		Possible				
Loose sand layer does not contain a cohesive soil			If there is more than 5m thickness of the layer, Suspect casing tube for drawing		Note the collapse accident. Muddy water specific gravity becomes lower. Consisting of a large amount of overflow.	Note the collapse accident.	Note the spring water. Earth retaining choice of method.
Loose sandy soil shallower than GL-10m			Denial of care to pull the casing tube. When there is a clay, available water in the hole by hull.		To build up a stable stratum standpipe.		
Underground obstacles			Can be removed by using a rotary drilling machine.		Possible removed if Workers put in the hole and not in the hole and water.		If you do not have a jet of combustible gas, including the steel is also acceptable.
Vibration			There is a vibration in the fall when drilling shallow depth Hammer-grab of time especially.		There is a vibration caused by the fall Hammer-grab standpipe at the time of installation, but in a short period of time.	Almost does not matter.	Almost does not matter.
Noise			There are noises by the collision of Hammer-grab.		Almost does not matter.	There arre noises the drop from the bucket when the excavated soil.	
Work space			According to the size of the drilling machine.		Muddy water plants need.	Plant must have a stable solution.	Most do not need.
Other			If the depth is deep drilling, Rotating drilling machine is widely used in construction such as the removal of obstacles.		Can accommodate the existing adjacent construction of Railways and existing structures, limit the pile head, pile deep in the earth to the narrow construction.	Diameter construction and depth has been increasing for Enlargement of the excavator and Up by the performance,	

7.2.2Superstructure

(1) Temporally facilities

Figure 7-8 shows Temporaly Facilities.

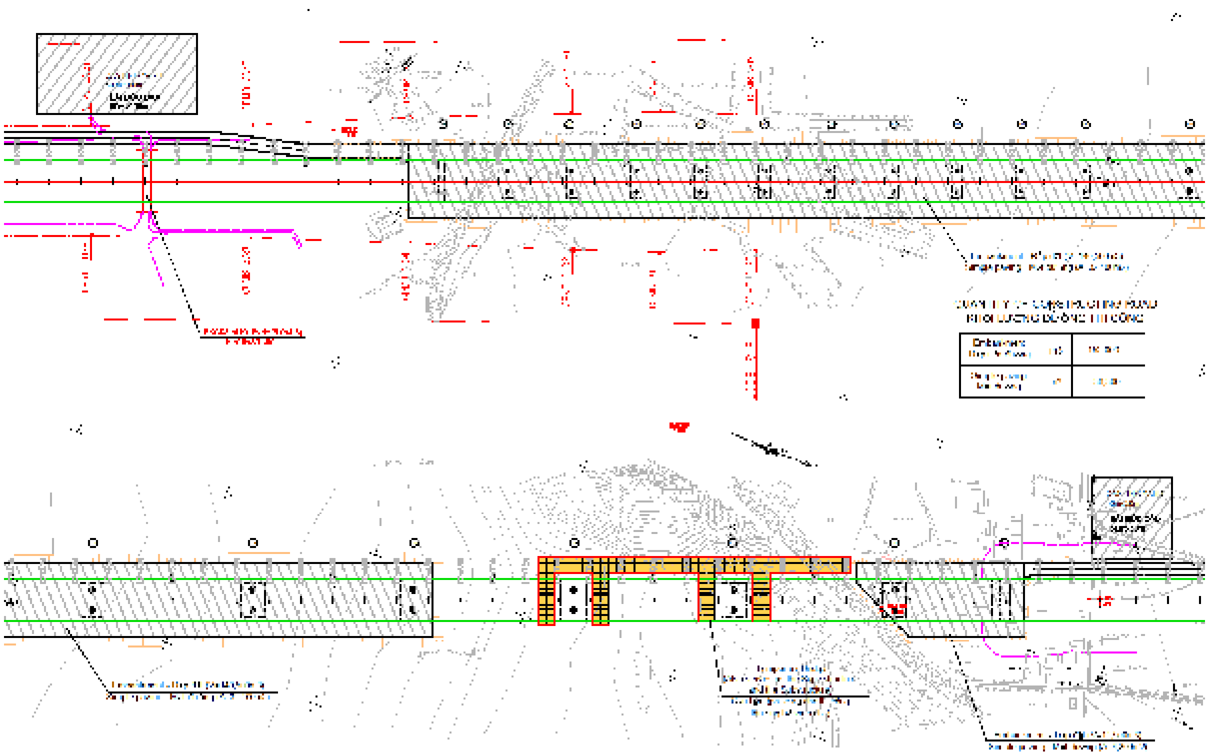


Figure 7-8 Temporaly Facilities

(2) ErectionMethod of SUPPER T- GIRDER

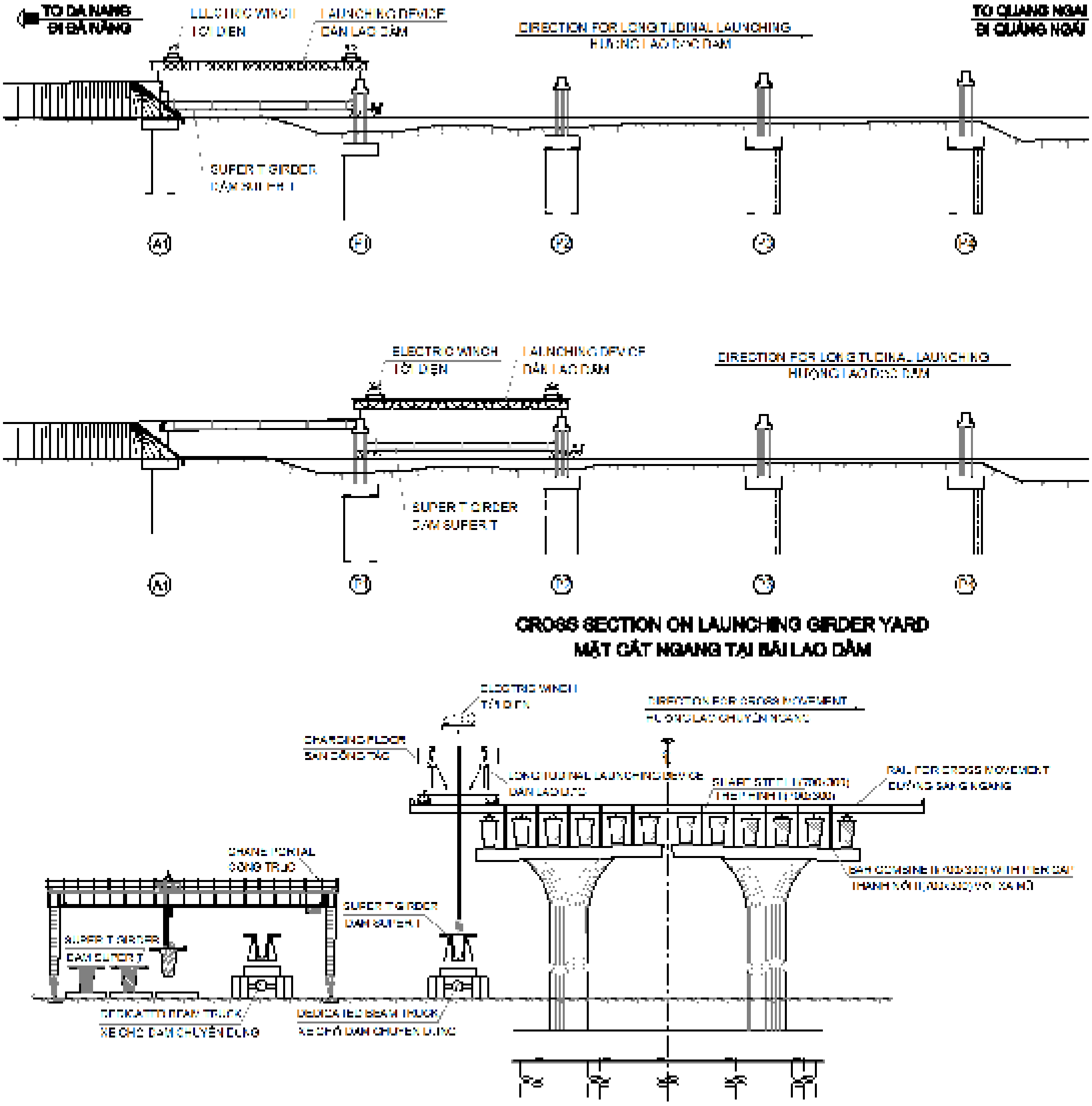


Figure7-9Erection Method of Super - T Girder

(3) Construction of Pier Head Segment

The construction of the box girder at column head level is generally done either by means of a fixed supporting bracket or fixed full-height scaffolding as illustrated below. The most appropriate form is dependent upon site specific construction and programming requirements and shall be the responsibility of the Contractor.

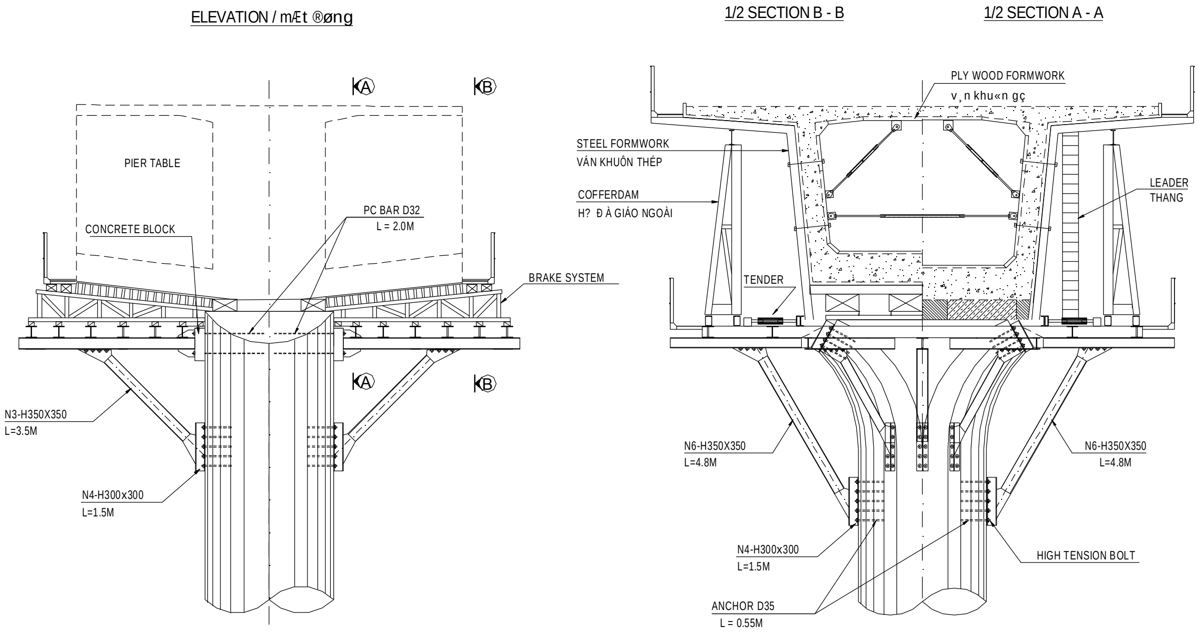


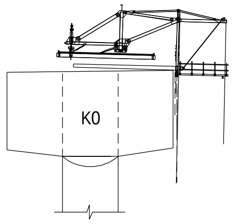
Figure 7-10 Construction of Pier Head Segment

(4) Cantilever Construction

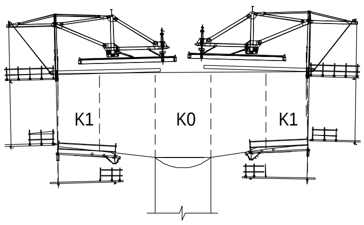
The cantilevering is undertaken in-situ by traveller and formwork supporting for side span, expansion of pier head for pier head segment.

Construction steps

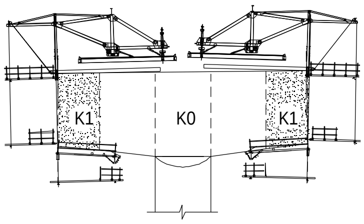
1. Traveller is assembled.



2. Fixing traveller from position of the first girder segment



3. Production of the first girder segment.



4. Moving traveller, formwork for production of next girder segment

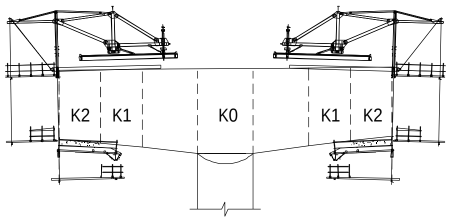


Figure 7-11 Cantilever Construction Steps

(5) Construction of Girder Side Spans

Most of the side spans shall be constructed by cantilevering, but some portion will be constructed by supporting method as show in Figure 7-12.

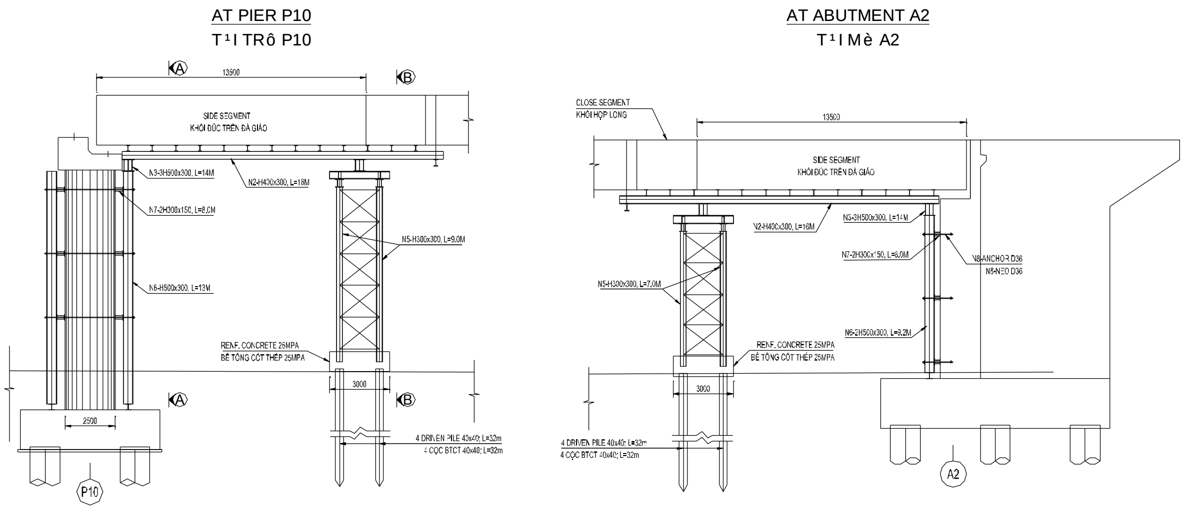


Figure 7-12 Construction of Girder Side Spans

8 MATERIALS (main item)

8.1 Concrete

Although concrete strength for each structural element shall basically follow the Vietnamese Standard considering local conditions, they may be modified based on the AASHTO LRFD and Japanese Specifications for reasons of required properties.

Table 8.1 Concrete Strength by Structural member

Compressive Strength at 28 days (MPa) (Cylinder Specimen)	Structural Member
50	Pre-tensioned Super T Girder
45	Free Cantilever PC box Girder
35	RC Deck slb, Diaphragm (Crossbeam)
30	Precast plank for Super T Girder Substructure (Pier, Abutment, Pile Caps, Wingwall)
25	Approach Slab Precast Parapet
15	Seal concrete (for construction pier cap under water)
10	Blinding CONCRETE

8.2 Reinforcing Bar

Three types of CB240-T, CB300-T and CB400-V shall be used.The properties and strength as shown in Table 8-2.

Table 8-2 Properties and Stress Limit of Reinforcing Bars

Type	Yield Strength f_y(MPa)	Tensile Strength f_u(MPa)	Modulus of Elasticity(MPa)
CB240-T	240	380	200,000
CB300-T	300	440	200,000
CB400-V	400	570	200,000

8.3 Prestressing Steel

Uncoated, stress-relieved or low-relaxation, seven-wire strand, or uncoated plain or deformed, high-strength bars, shall have the following properties and strength as shown in Table 8-3.

Table 8-3 Properties of Prestressing Strand and Bar (5.4.4-1 22TCN 272-05)

Material	Grade or Type	Diameter(mm)	TensileStrength f_{pu} (MPa)	Modulus ofElasticity E_p (MPa)	Yield Strength f_{py} (MPa)
Strand	1725MPa (Grade 250)	6.35-15.24	1725	197,000	$0.85f_{pu}$ for stress-relieved $0.90f_{pu}$ for low-relaxation
	1860MPa (Grade 270)	9.53-15.24	1860		$0.90f_{pu}$
Bar	Type 1, Plain	19-35	1035	207,000	$0.85f_{pu}$
	Type2, Deformed	16-35	1035		$0.80f_{pu}$

Stress limits for each tendon type are as shown in Table 8-4.

Table 8-4 Stress Limits for Prestressing Tendons (5.9.3.1 - 22TCN 272-05)

Item	Tendon Type		
	Stress-relieved Strand/ Plain high-strength bars	Low Relaxation Strand	Deformed High-strength Bars
Pre-tensioning			
- Immediately prior to transfer($f_{pt}+\Delta f_{pES}$)	$0.70f_{pu}$	$0.75f_{pu}$	-
- At service limit state after all losses (f_{pe})	$0.80f_{py}$	$0.80f_{py}$	$0.80f_{py}$
Post-tensioning			
- Prior to seating–short-term f_s may be allowed	$0.90f_{py}$	$0.90f_{py}$	$0.90f_{py}$
- At anchorages and couplers immediately after anchor set ($f_{pt}+\Delta f_{pES}+\Delta f_{pA}$)	$0.70f_{pu}$	$0.70f_{pu}$	$0.70f_{pu}$
- At end of the seating loss zone immediately after anchor set ($f_{pt}+\Delta f_{pES}+\Delta f_{pA}$)	$0.70f_{pu}$	$0.74f_{pu}$	$0.70f_{pu}$
- At service limit state after all losses (f_{pe})	$0.80f_{py}$	$0.80f_{py}$	$0.80f_{py}$

8.4 Temporary material (Angle steel & plate steel_TCXDVN 338 : 2005)

The steel to be used for structure design should be Mactank or oxygen rotary-kilned types by either boiling pouring or (semi) electro-statistic methods with equivalent grades of CCT34, CCT38 (or CCT38Mn), CCT42 meeting TCVN 1765:1975 or TCVN5709:1993. The low grade alloy shall follow TCVN 3104:1979

Table 8-5 Rated strength (f_y, f_u) and calculates yield strength (f) of carbon steel

Steel Grade	Rated tensile strength (f_u) N/mm^2	Rated yield strength (f_y) and calculates yield strength (f), N/mm^2 in accordance with thickness, mm					
		t ≤ 20		20<t≤40		40<t≤100	
		f_y	f	f_y	f	f_y	f
CCT 34	340	220	210	210	200	200	190
CCT38	380	240	230	230	220	220	210
CCT42	420	260	245	250	340	240	230

9 CONSTRUCTION SCHEDULE

The construction schedule is shown next page.