



*Ministry of Transport*



*Vietnam Expressway Corporation*



*Project Management Unit No. 85*



THE WORLD BANK

IDA Credit No. : 3843-VN

Project ID No. : P106235

**Consulting Services  
for  
Detailed Design for Da Nang - Quang Ngai Expressway Development Project**

**Basic Design Report  
(Package 3A, KM16+880 - KM18+100)**

May 30 , 2012

**The Joint Venture of**



**NIPPON KOEI CO.,LTD.**



**NIPPON ENGINEERING CONSULTANTS CO.,LTD.**



**CHODAI CO.,LTD.**



**THAI ENGINEERING CONSULTANTS CO., LTD.**



Consulting Services for Detailed Design for  
 Da Nang Quang Ngai Expressway Development Project  
 (DQEDP-DD)

Project Location Map

Letter of Submission  
Project Location Map

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### **List of Abbreviations**

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 Introduction**

### **1.1 Objective**

The objective of this Basic Design Report of Package 3A, Civil, is to show the result of the basic design study to be confirmed by the relevant organization before the commencement of the detail design of this package.

### **1.2 Background**

The preparation of the Project was started as BOT project back in the year 2000. However, this BOT scheme Project did not materialize because of funding sources were not identified at that time.

In the year 2007, the Project was approved as one of the top priority projects in transport sector by GOVN. In order to carry forward the Project, GOVN requested JETRO to assist a further study expecting materialization of the Project by a JBIC (currently JICA) loan scheme in June 2007. JETRO conducted the study and submitted the study report to MOT on April, 2008.

In parallel with the JETRO study, WB declared GOVN to be eligible for the IBRD loan in November, 2007 and the Project was identified as the top priority use for the loan. After submission of the JETRO study report, WB undertook the identification missions in April and June, 2008 and confirmed necessity of updating the JETRO study to meet his requirements and decided to allocate the fund from on-going RNIP (IDA Credit No.: 3843-VN) to conduct the WB supplemental study. The study report was prepared by PMU85 and submitted to MOT in his letter No. 551/BQ1-KHDA2 dated on June 13, 2009.

In response to the supplemental study, WB engaged an international consultant and undertook the WB appraisal study. In the appraisal study, WB modified the alignment at three (3) sections by taking into consideration social and environmental issues. Based on the modified alignment, TEDI updated the supplemental study and submitted as the draft F/S report to MOT in April, 2010. The draft F/S report was also finalized by TEDI in accordance with the MOT appraisal report No. 6188/BGTVT-KHDT dated on September 8, 2011 and submitted by VEC as the F/S report to MOT in September 2010. The F/S report was approved by MOT in Decision No. 2656/QD-BGTVT dated on September 10, 2010.

In parallel with the F/S approval, WB agreed to allocate the fund from RNIP for D/D and the Prime Minister allowed commencing the procurement of D/D consultant. Through the procurement procedures, the Joint Venture of Nippon Koei Co., Ltd., Nippon Engineering Consultants Co., Ltd., Chodai Co., Ltd., and Thai Engineering Consultants Company Limited (the Consultant) was selected and signed the contract with PMU85 on November 15, 2011. Consequently, the Consultant Service was officially commenced on December 1, 2011.

The construction works of the Project is required to be commenced in September 2012 in accordance with the Minutes of the Second Contract Negotiation dated on October 15, 2011. In response to this requirement, Package 3A, the Ky Lam Bridge section, was proposed as the first priority in the procurement plan prepared by the Consultant and it is under review and approval processes by relevant organizations.

### **1.3 Location**

The Project road is a part of the North-South Expressway located in parallel with the existing NH1A and North-South Railway and passing through Da Nang city, Quang Nam and Quang Ngai provinces in the central region. The road starts at the intersection of the Da Nang Bypass and NH14B in Da Nang city and ends at the connecting point with the planned City Ring Road at existing NH1A in Quang Ngai province.

Package 3A is the section from KM16+880 to KM18+100 (Length: 1220m) located in Quang Nam Province. Ky Lam Bridge (Length: 1030m) crossing the Thu Bon River at KM17+492 is the main component of this Package (see the Project Location Map).

### **1.4 Pre-conditions**

#### **1.4.1 Agreement and Understanding in the F/S**

Following official documents related to the F/S are reviewed in the Basic Design:

- Official letter Ref. 1732/UBND-KTN dated on May 31, 2010 regarding some comments about Feasibility Study of Da Nang – Quang Ngai expressway

- Decision No.2656/QD-BGTVT dated on September 10, 2010 regarding approved Feasibility Study of Da Nang – Quang Ngai expressway
- Minute of Meeting between Dien Tho Commune People Committee and Transport Engineering Consultant Company No. 5 (FS consultant) dated on February 05, 2010 regarding cross road, underpass, cross culvert

#### 1.4.2 Available Reports Related to the Basic Design Study

Considering above mentioned urgency of Package 3A, this Basic Design Report was prepared prior to a submission of several reports which would define the fundamental conditions of the study. In this regard, the situations of the other studies necessary for the design of the bridge as well as pre-conditions regarding those studies were summarized in Table 1.1.

**Table 1.1 Application of the Reports Related to the Basic Design Study**

No.	Reports in the Service		Work Progress	Applied Pre-conditions in This Study
1	General Reports	Review Report (Civil)	On-going	Applied draft review results
2		Detailed Engineering Design Framework (Applicable Design Standard)	Submitted	Applied design standards (Letter No. DQEDD-PMU85-12-13)
3	Survey Reports	Control Point and Topographic Surveys Report	On-going	Applied topographic survey results
4		Hydrological/Inundation Analyses Report (Da Nang/Quang Nam)	Submitted	DQEDD-PMU85-76-12
5		Geotechnical and Geological Investigations Report	On-going	Referred F/S data
6	Technical Reports	Design Criteria and Conditions (Bridge Design)	Submitted	Applied design criteria and conditions (Letter No. DQEDD-PMU85-12-12)
7		Typical Cross Sections	Submitted	Typical Cross Sections Report (Letter No. DQEDD-PMU85-139-12)
8		Geometric Design (Thruway, PKG3A)	On-going	Applied draft geometric design
9		Revetment/River Bed Protection Design (PKG3A)	Not commenced	Not studied details in this study
10	Discussion Papers	Alternative Alignment Study Report	Submitted on 4/1/2012 (Rev.2)	Applied the study results
11		Cross Structure Plan	On-going	Applied draft cross structure plan

#### 1.5 Alternative Study Report of Ky Lam Bridge

The optimum bridge plan for Ky Lam Bridge was proposed by the Consultant in the Discussion Paper titled Alternative Study Report (Ky Lam Bridge, Revision 2) dated January 4, 2012 taking into account the urgency of Package 3A. On the revision 1 of the report, several comments were made by PMU85, VEC and other relevant organizations during the meetings held on December 24, 2011 in Da Nang, and December 27, 2011 in Hanoi. And World Bank mission was conducted from 13<sup>th</sup> Feb. to 15<sup>th</sup> Feb. The Consultant was requested to study more in order to save construction cost. The major comments made by the organizations in these meetings and the responses on them by the Consultant as well as the optimum bridge features are summarized in Table 1.2.

**Table 1.2 Instructions and Comments from the Relevant Organizations on the Alternative Study Report for Ky Lam Bridge**

Attendants	Date of Meeting	Instructions and Comments	Remarks
PMU85, the Consultant	Dec 24, 2011	<ul style="list-style-type: none"> <li>- The concept of the design is agreed.</li> <li>- The cost for the F/S span arrangement with 6 lanes should be mentioned.</li> </ul>	
VEC PMU85, PMU1, TEDI, the Consultant	Dec 27, 2011	<ul style="list-style-type: none"> <li>- The width of the bridge shall be 26m as planned in the F/S.</li> <li>- Locations of the both abutments recommended by the Consultant (behind the bank protections) are agreeable.</li> <li>- A cylindrical pier shape recommended by the Consultant is agreeable.</li> <li>- The span arrangement of the superstructure should be same as in the F/S to avoid the cost increase, however, the main spans (100m with PC box girder) can be shifted to accommodate the actual river channel on the right bank side. In this regard, sufficient navigational clearance shall be secured at a span on the actual river channel.</li> </ul>	All the instructions are reflected in the Revision 2 of the Alternative Study Report submitted on January 4, 2012.

Attendants	Date of Meeting	Instructions and Comments	Remarks
VEC, MOT, PMU85, PMU1, TEDI, WB, the Consultant	Jan 10, 2012	<ul style="list-style-type: none"> <li>- Super Tee girders shall be applied instead of PC-I girders.</li> <li>- WB commented that further discussion is necessary to decide the width (the number of lanes and width of carriageways).</li> </ul>	The instruction by VEC on applying Super Tee girders is reflected in this Basic Design Report. However, the finalization on width of the bridge is waiting for the decision of MOT/WB.
VEC, PMU85, PMU1, WB, The Consultant	Feb 15, 2012	<ul style="list-style-type: none"> <li>- WB commented that For Major river bridges with box girder (Ky lam, Chiem Song, Tra Khuc) are recommended to construct 6 lanes in the first stage and for these long bridges, due to economic reasons, emergency lanes can be replaced by right bands.</li> </ul>	2012/2/13-2012/2/15
MOT, VEC, PMU85, PMU1, TEDI, WB, The Consultant	Feb 17, 2012	<ul style="list-style-type: none"> <li>- Cross Section: Design and Construction for large bridge (L=100m) need to be carried out one times appropriate to initial and ultimate stages.</li> <li>Lighting: It is agreed with WB suggestion on cancellation of this item for whole section even large bridge except for toll station and service areas in order to save construction and operation cost.</li> <li>Structure of Ky Lam Bridge: It should be studied appropriate for topography and cost saving.</li> </ul>	Wrap-up meeting with WB Mission
VEC, PMU85, PMU1, TEDI, The Consultant	28 March 2012	<ul style="list-style-type: none"> <li>- Alternative 3A (10@40m;65m+5@100m+65m) was chosen as being agreed by TCQM, VEC, PMU85, PMU1 at the site checking meeting for DQEP on 28Feb-29Feb.</li> <li>- Consultant is requested to immediately carry out geological survey for detailed design of PKG3A to meet the commencement target of the Project. It is agreed with proposal of Consultant which is narrowing the median from B=2.0m (F/S) to B=1.5m to be appropriate to Standard TCVN5729-97.</li> <li>- Consultant is requested to have explanation for TEDI's comment on relocating A2 abutment toward the right side of Ky Lam Bridge.</li> </ul>	-Submitted Letter to PMU85 <u>Further Study on Structure Option for Ky Lam Bridge</u>

## 1.6 Summary of the Study Results

The main features of Ky Lam Bridge as a result of this Basic Design Study are summarized in Table 1.3:

**Table 1.3 Main Features of Ky Lam Bridge**

No.	Items	F/S (Original Plan)	Alternative (Proposed Plan)
1	Station (Bridge Section)	KM017+662	KM017+500
2	Bridge Length	950m (Girder Length)	1,030m (Girder Length)
3	Bridge Width	26m (Initial Stage: 4 lanes)	26m (Initial Stage: 4 lanes)
4	Span Arrangement	4@40m+65m+5@100m+65m+4@40m	10@40m+65m+7@100m+65m
5	Superstructure Type	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder
6	Support Conditions	Not specified	To be examined
7	Navigational Clearance	6m*40m (6m*75m in consideration of 30 degree of skew)	6m x 30m (6m x 50m in consideration of 45 degree of skew)
8	Pier Shape	Wall type	Circular type

It shall be noted that no geotechnical investigation is conducted during this basic design study stage. In this basic design study, the dimensions of the bridge were preliminary determined based on the

geotechnical condition applied in the previous studies. Further analysis on the foundation as well as on the structural frame can be conducted after the geotechnical investigation in D/D stage.

## 2 Natural Condition Surveys

### 2.1 Topographic Surveys

The Consultant Services was officially commenced on December 1, 2011. However, the topographic survey works were commenced in July 2011 in accordance with the Minutes of Contract Negotiation dated May 26, 2011, and the field works for PKG-3A were completed in October 2011. A preparation of the survey reports are in progress together with other sections.

#### 2.1.1 Technical Standards

Technical standards applied to the survey are listed in Table 2.1.

**Table 2.1 List of Technical Standards**

No.	Standard code	Description	Issued Year
1	TCXDVN 364:2006	The technical specification for engineering survey - GPS monitoring and processing	2006
2	QCVN 11:2008	National technical regulation on establishment of leveling network	2008
3	22TCN 263_2000	Process for survey of motorway	2000
4	96TCN 43-90	Specification for topographical measurement	1995
5	22TCN 220-95	Standard for calculation of flood runoff specifics	1995
6	22TCN 262 - 2000	Process for survey of motorway on soft ground	2000
7	96 TCN 42-1990	Standard for topographic map on scale of 1:500, 1:1000, 1:2000, 1:5000, 1:10000, 1:25000	1990
8	TCXDVN 309-2004	Geodesy works in engineering – General requirements	2004

#### 2.1.2 Control Point Surveys

Control point surveys were conducted in accordance with Survey Plan for Primary/Secondary Control Net Work submitted on August 8, 2011 complying with the comments made by VEC on August 3, 2011, as well as the TOR of the Service. Following are the work items carried out:

- Collecting data of National control network;
- Establishment of Bench Marks for GPS point in the field - new section;
- Measuring coordinates and elevation of the newly established points;
- Connecting project control points to the National control network;
- Verification of the new network with the network established in the feasibility study stage;
- Measuring and testing of points established in the feasibility study stage;
- Calculation of primary control network - grade IV;
- Provision of results for the traverse control network to subsequent topographic survey
- Provides detailed survey units data traverse control network;
- Prepare reports for primary control network.

#### 2.1.3 Topographic Surveys

Topographic surveys were conducted in accordance with Work Plan for Topographic Survey submitted on November 14, 2011 and approved by PMU85 on December 13, 2011, as well as the TOR of the Services. Following are the work items carried out:

The main line:

- Plan metric survey on scale 1:1000;
- Setting out alignment on site;
- Profile survey on horizontal 1:1000 and vertical 1:100;
- Cross-section survey on scale 1:200.

The bridge:

- Establishment of control network for the bridge;
- Planimetric survey on scale 1:500
- Profile survey on horizontal 1:500 and vertical 1:500.
- Cross-section survey on scale 1:200.
- Survey for hydrologic flow sections: Profile of river-bed (on horizontal 1/1000, and vertical 1/100), section of downstream and upstream. (scale 1/200)

## 2.2 Geotechnical and Geological Survey

Boring investigations will be conducted at all abutments and piers as well as at the approach roads after the confirmation of these locations through the approval of this Basic Design Report.

In this Basic Design Study, the geological data in the previous studies were utilized.

## 2.3 Hydrological and Inundation Analysis

The summary and major results of hydrological analysis for Ky Lam Bridge crossing the Thu Bon River are shown in this section. These contents are extracted from the draft Hydrological Analysis Report which is planned to be finalized in February, 2012.

### 2.3.1 Introduction

The expressway mostly passes through the flat floodplains at foothills of mountains between Da Nang and Quang Ngai which are vulnerable to flood and inundation. Vu Gia, Thu Bon, Tam Ky, Tra Bong and Tra Khuc are the major rivers which cause flood and inundation problems on floodplains by heavy rainfalls during rainy season in this region. To mitigate damages caused by flood and inundation, World Bank and JICA have carried out the projects to develop flood management system in this region. Therefore, careful consideration of hydro-meteorological conditions of this region is important for designing the expressway.

### 2.3.2 Technical Standards

The following technical standards were taken into consideration for calculating the river flow, conducting hydrological surveys, determining high water levels, designing bridges and culverts.

**Table 2.2 Technical Standards**

S. N.	Description	Standard
1	Process for survey of motorway	22TCN 263-2000
2	Specification for topographical measurement	96TCN 43-90
3	Rules on monitoring river flows to the areas affected by tide	94TCN 17-99
4	Rules on monitoring water levels and river water temperature	94TCN 1-2003
5	Rules on monitoring the flow of big rivers, medium rivers of the region has no effect on tidal	94TCN 3-90
6	Standard for calculation of flood runoff	22TCN 220-95
7	Standard for designing culvert	22TCN 18-79
8	Highway design requirements	TCVN 4054-1998
9	Standard for designing highway	22TCN 273-2001
10	Handbook of hydrological and hydraulic analysis of bridges and roads	BGTVT 2006
11	Navigation clearance requirements of rivers	TCVN 5664-2009

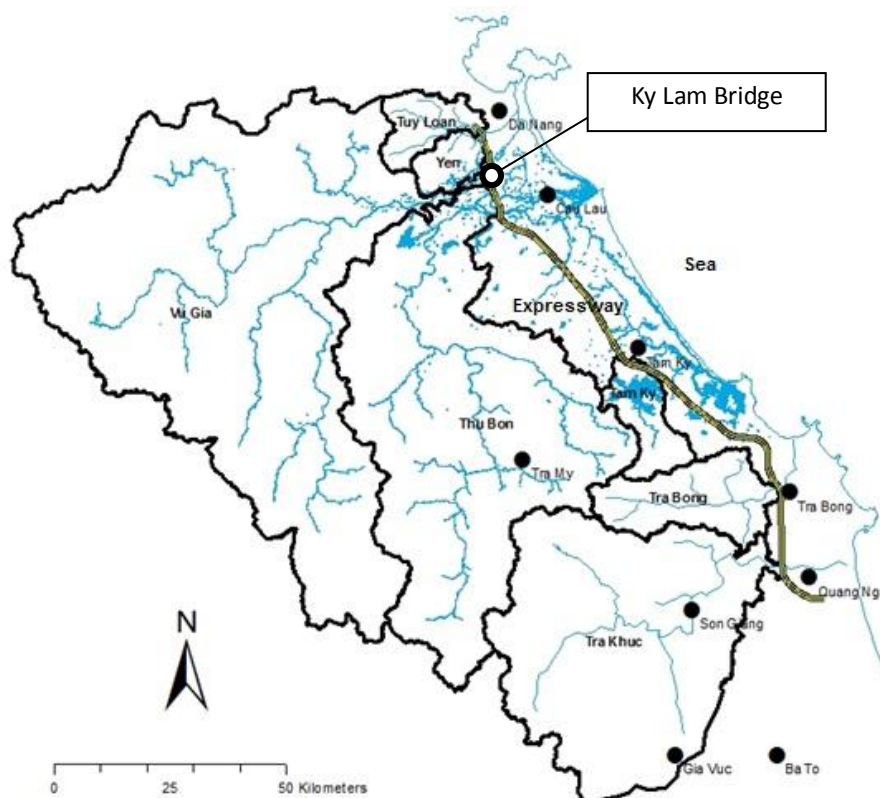
### 2.3.3 Rainfall Analysis

#### (1) Rainfall Stations

There are Da Nang, Cau Lau, Tam Ky, Tra My, Tra Bong, Quang Ngai, Gia Vuc and Ba To rainfall stations in the project area (Figure 2.1) Historical annual maximum daily rainfalls and hourly rainfalls during 2009 heavy flood of those stations are collected and analyzed. The availability of data, latitude and longitude of the stations are shown in Table 2.3.

**Table 2.3 Rainfall Stations in Project Area.**

Station	Location	Latitude (N)	Longitude (E)	Data Availability
Da Nang	Da Nang	16° 02'	108° 11'	1947-2010
Cau Lau	Quang Nam	15° 51'	108° 17'	1977-2010
Tam Ky	Quang Nam	15° 34'	108° 28'	1977-2010
Tra My	Quang Nam	15° 21'	108° 14'	1978-2010
Tra Bong	Quang Ngai	-	-	1976-2010
Quang Ngai	Quang Ngai	15° 08'	108° 47'	1958-2010
Gia Vuc	Quang Ngai	14° 42'	108° 34'	1977-2010
Ba To	Quang Ngai	14° 46'	108° 44'	1976-2010



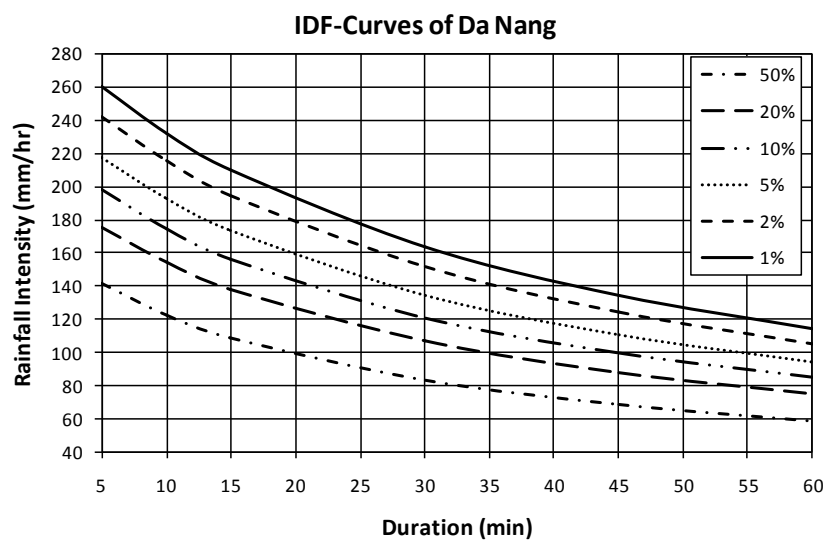
**Figure 2.1 Locations of Rainfall Stations**

#### (2) Rainfall Intensity Analysis

The intensities of short duration rainfalls like 5-min, 10-min, 15-min, 30-min, 45-min and 60-min are estimated for 1%, 2%, 4% and 5% probability levels using the IDF-Curve relations (Table 2.4 and Figure 2.2). For instance, 5-min design rainfall intensities are: 260 mm/hr (1% P), 242 mm/hr (2% P), 224 mm/hr (4% P) and 217 mm/hr (5% P). Similarly, 60-min design rainfall intensities are: 114 mm/hr (1% P), 105 mm/hr (2% P), 97 mm/hr (4% P) and 94 mm/hr (5% P).

**Table 2.4 Rainfall Intensity of Da Nang Estimated by IDF-Curve**

Duration	Rainfall Intensity (mm/hr)							
	50% P	33.3% P	20% P	10% P	5% P	4% P	2% P	1% P
5	142	159	176	198	217	224	242	260
10	122	138	154	174	192	198	215	232
15	109	123	138	156	173	178	194	210
30	83	94	107	121	134	138	151	163
45	69	78	88	99	110	114	124	134
60	59	67	75	85	94	97	105	114



**Figure 2.2 Rainfall IDF-Curves of Da Nang**

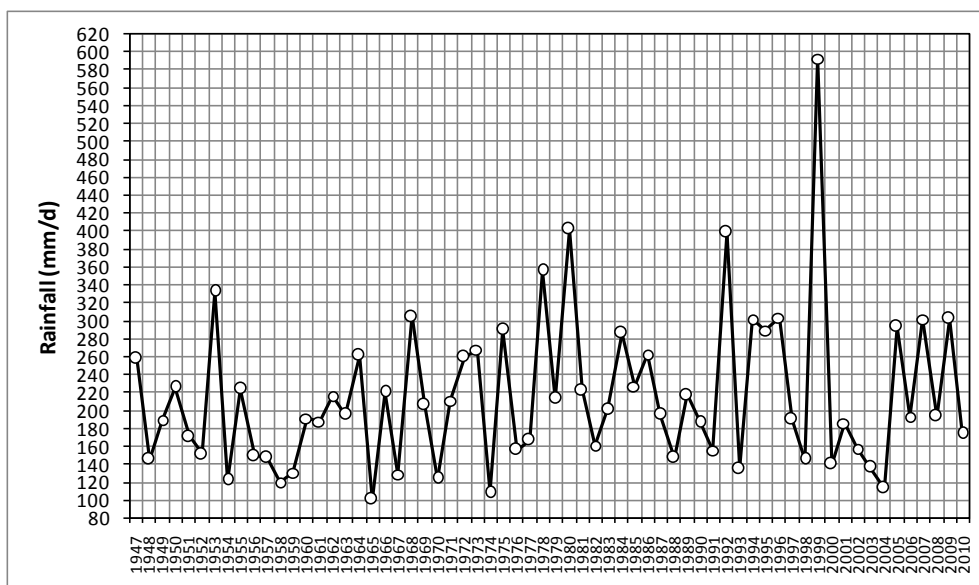
### (3) Frequency Analysis of Annual Maximum Daily Rainfalls of Da Nang and Cau Lau Stations

#### (a) Da Nang

The historical records of annual maximum daily rainfall of Da Nang during 1947-2010 are shown in Table 2.5. The highest annual maximum daily rainfall of 592.6 mm was recorded in 1999 and the lowest annual maximum daily rainfall of 100.2 mm was recorded in 1965. The variation in annual maximum daily rainfalls among the years is shown in Figure 2.3.

**Table 2.5 Annual Maximum Daily Rainfall of Da Nang**

Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)
1947	257.2	1960	190.4	1973	267.1	1986	262.2	1999	592.6
1948	144.5	1961	187.0	1974	108.0	1987	194.9	2000	139.7
1949	188.5	1962	215.6	1975	289.5	1988	146.6	2001	184.9
1950	224.9	1963	195.1	1976	155.5	1989	216.8	2002	156.6
1951	170.5	1964	260.7	1977	166.6	1990	186.6	2003	136.0
1952	150.8	1965	100.2	1978	355.4	1991	155.0	2004	112.5
1953	332.3	1966	219.7	1979	212.4	1992	398.2	2005	293.4
1954	121.9	1967	128.0	1980	402.5	1993	134.7	2008	192.7
1955	223.6	1968	304.4	1981	222.1	1994	301.3	2009	302.1
1956	149.1	1969	205.9	1982	160.4	1995	288.8	2010	173.2
1957	146.9	1970	123.0	1983	200.8	1996	303.0		
1958	119.2	1971	209.9	1984	286.1	1997	189.4		
1959	130.0	1972	259.1	1985	226.4	1998	144.6		

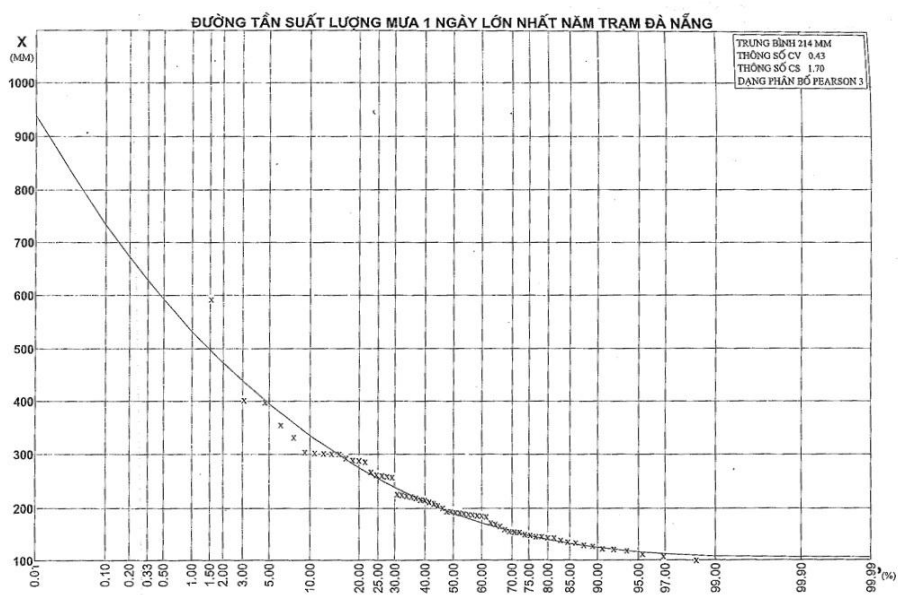


**Figure 2.3 Annual Maximum Daily Rainfalls of Da Nang**

The results of the frequency analysis of annual maximum rainfalls carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Tabel 2.6. The certified daily rainfalls by HMC are 533 mm/d and 394 mm/d for 1% and 5% exceeding probability levels, respectively. The fitting of distribution function with observed annual maximum rainfalls is shown in Figure 2.4.

**Table 2.6 Design Daily Rainfalls of Da Nang**

Recurrence Probability Level		HMC Certified
Year	% P	Rainfall Amount (mm/d)
2	50.0	190
3.3	30.0	238
5	20.0	274
10	10.0	335
20	5.0	394
33.3	3.0	438
50	2.0	473
100	1.0	533
200	0.5	592



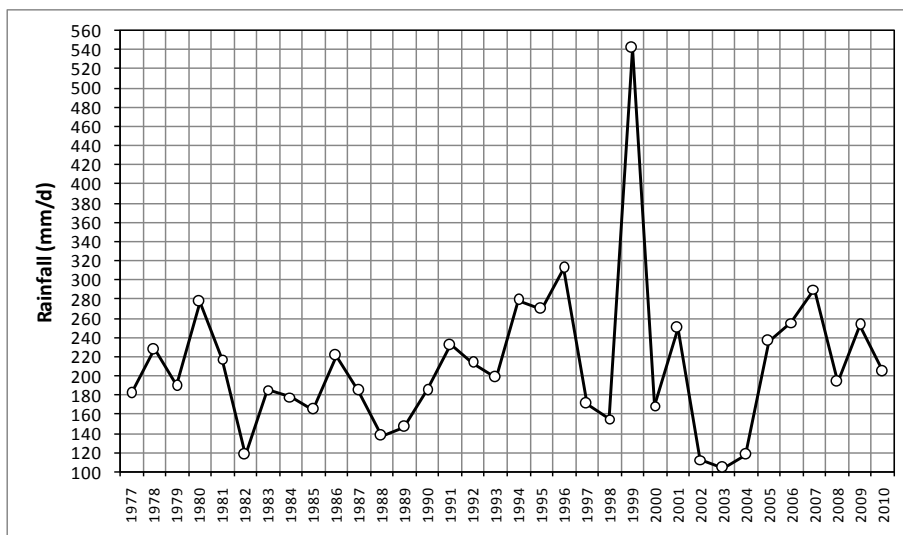
**Figure 2.4 Frequency Analysis of Annual Maximum Daily Rainfalls of Da Nang**

**(b) Cau Lau**

The historical records of annual maximum daily rainfall of Cau Lau during 1977-2010 are shown in Table 2.7. The highest annual maximum daily rainfall of 541.9 mm was recorded in 1999 and the lowest annual maximum daily rainfall of 103.1 mm was recorded in 2003. The variation in annual maximum daily rainfalls among the years is shown in Figure 2.5.

**Table 2.7 Annual Maximum Daily Rainfall of Cau Lau**

Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)	Year	Max Rainfall (mm/d)
1977	181.0	1984	177.3	1991	231.9	1998	154.6	2005	236.2
1978	227.3	1985	164.0	1992	213.0	1999	541.9	2006	255.0
1979	189.2	1986	220.8	1993	198.0	2000	168.3	2007	290.0
1980	277.0	1987	184.3	1994	278.6	2001	249.4	2008	193.4
1981	217.0	1988	137.1	1995	269.1	2002	111.8	2009	252.5
1982	117.0	1989	146.2	1996	312.0	2003	103.1	2010	203.7
1983	184.9	1990	184.5	1997	170.7	2004	116.8		

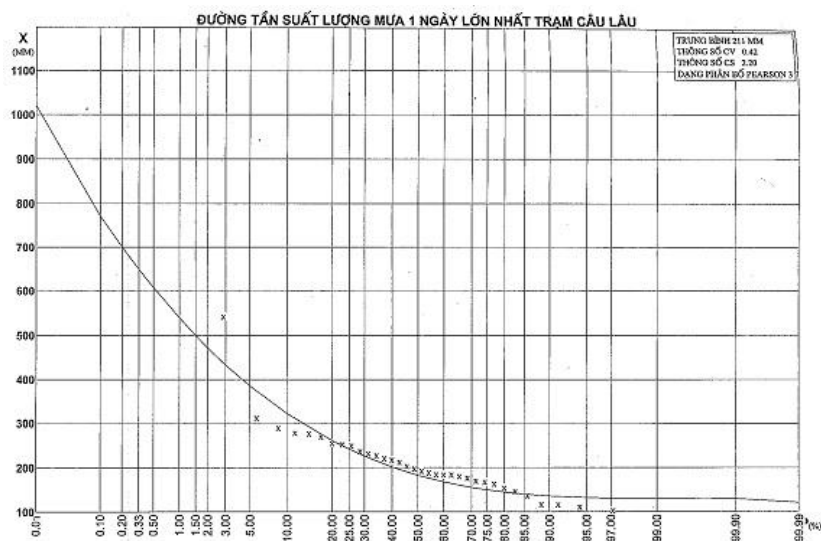


**Figure 2.5 Annual Maximum Daily Rainfalls of Cau Lau**

The results of frequency analysis of annual maximum rainfalls carried out by Hydro Meteorological Center (HMC), Hanoi are shown in Tabel 2.8. The certified daily rainfalls by HMC are 539 mm/d and 385 mm/d for 1% and 5% exceeding probability levels, respectively. The fitting of distribution function with observed annual maximum rainfalls is shown in Figure 2.6.

**Table 2.8 Design Daily Rainfalls of Cau Lau**

Recurrence Probability Level		HMC Certified
Year	% P	Rainfall Amount (mm/d)
2	50.0	183
3.3	30.0	226
5	20.0	261
10	10.0	322
20	5.0	385
33.3	3.0	433
50	2.0	471
100	1.0	539
200	0.5	607



**Figure 2.6 Frequency Analysis of Annual Maximum Daily Rainfalls of Cau Lau**

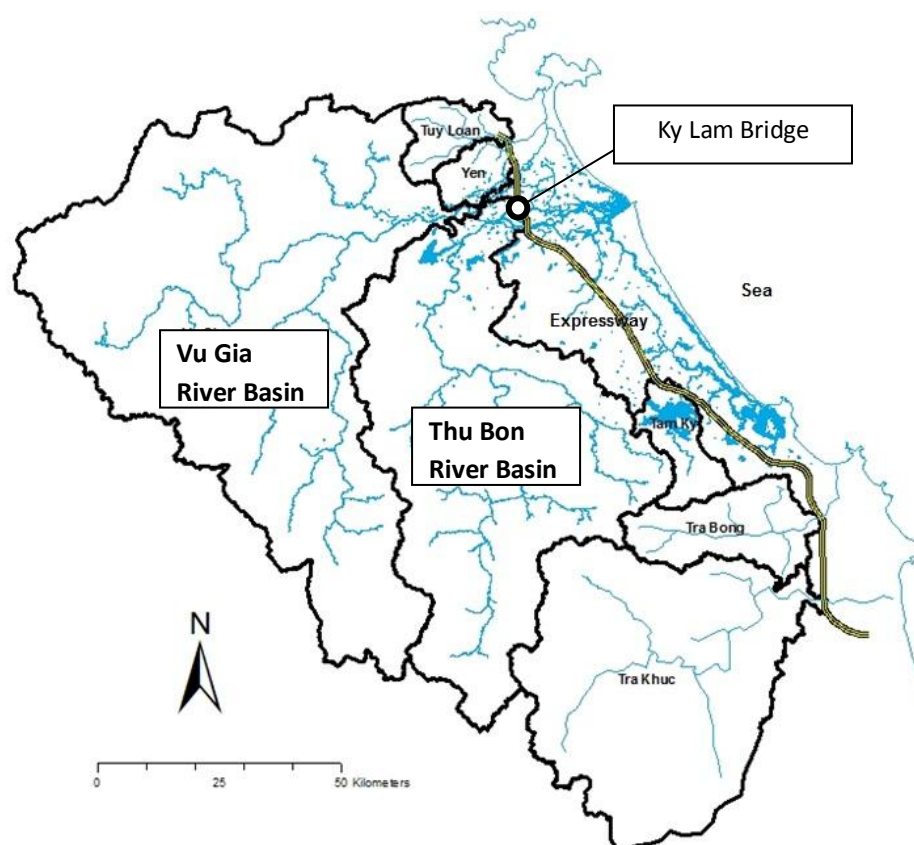
### 2.3.4 River System of Vu Gia -Thu Bon River

The rivers network and their basins are shown in Figure 2.7. The Thu Bon River and some part of the flow of the Vu Gia River are jointly flow into Ky Lam Bridge\*. The catchment areas and estimated 1% exceeding probability flows of the rivers are shown in Table 2.9. The catchment areas of rivers are 5,793 km<sup>2</sup> (Vu Gia River) and 3,588 km<sup>2</sup> (Thu Bon River). The estimated 1% discharge of the rivers at expressway are 15,903 m<sup>3</sup>/s (Vu Gia River) and 23,655 m<sup>3</sup>/s (Thu Bon River).

**Table 2.9 Catchment Areas and Estimated Flows of Rivers**

S. N.	River	Location	Catchment Area (km <sup>2</sup> )	Estimated 1% Discharge (m <sup>3</sup> /s)
1	Vu Gia (Tuy Loan)	Expressway	5793	15,903**
2	Vu Gia (Yen)	Expressway		
3	Vu Gia	Before bifurcating the river at Ai Nghia	5405	25,394
4	Vu Gia	Thanh My	2045	9,608
5	Thu Bon	Expressway	3588	23,655*
6	Thu Bon	Nong Son	3187	13,613

Note: \* assumed that 33% flow of Vu Gia goes to Thu Bon at Ai Nghia and the flow is shared by Ky Lam and Chiem Son. \*\* assumed that after going 33% of Vu Gia flow to Thu Bon at Ai Nghia again 25% of remaining flow of Vu Gia goes to La Tho and ultimate flow is shared by Tuy Loan and Yen



**Figure 2.7 Rivers and their Basins**

Vu Gia and Thu Bon River basins cover large parts of Quang Nam province and some parts of Da Nang, Kontum and Quang Ngai provinces. The Vu Gia-Thu Bon river system originates on the Eastern side of the Truong Son mountain range and has a total catchment area of 10,350 km<sup>2</sup>. Vu Gia River is 204 km long and it flows into the sea in Da Nang. The tributaries of Vu Gia are Dak Mi, Bung and Con rivers. Similarly, Thu Bon River is 152 km long and it originates at an elevation of more than 2,000 m. The Ngoc Linh Mountain (2,598 m) is the highest point in the basin, where slope varies from 20° to 30°. After

passing through mountains area, Thu Bon River flows through large uplands, floodplains and coastal areas. The lowest point in coastal areas is the Cuadai Estuary (0-1 m). The coastal lowlands are densely populated and agricultural lands.

There is a considerable variation in spatial distribution of rainfall in the river basin. The 1% rainfall of stations in basin are 533 mm/d (Da Nang), 539 mm/d (Cau Lau), 515 mm/d (Tam Ky) and 637 mm/d (Tra My). The high elevation areas of the basin get larger amount of rainfall than flat floodplain areas. The 1% specific discharge of Thu Bon River is 4.271 m<sup>3</sup>/s/km<sup>2</sup> whereas that of Vu Gia River is 4.698 m<sup>3</sup>/s/km<sup>2</sup>.

### 2.3.5 Hydrological Studies

#### (1) Hydrological Stations

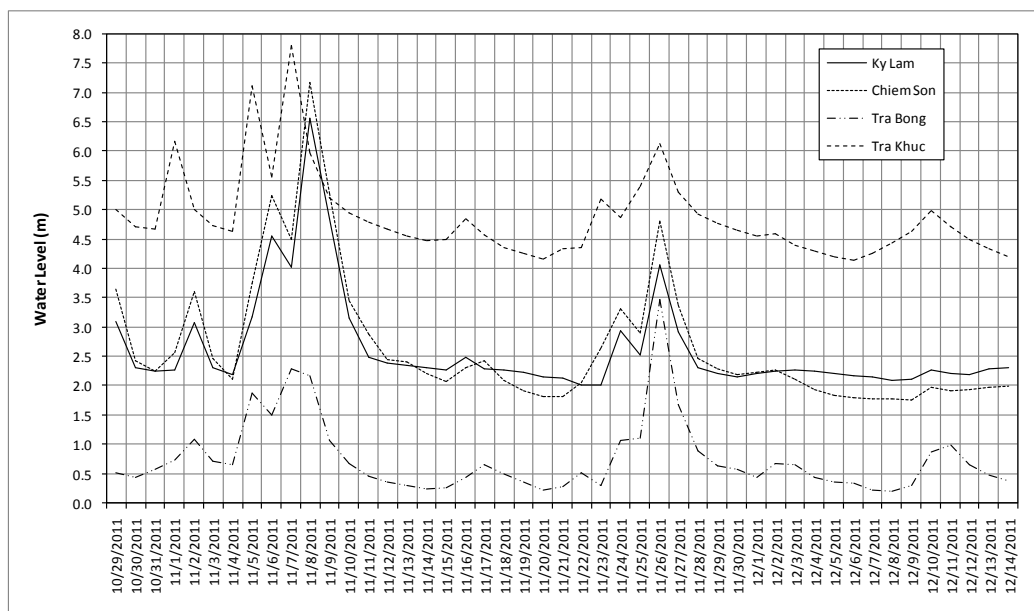
Ai Nghia, Giao Thu and Cau Lau hydrological stations are related to Ky Lam Bridge. The name of river, availability of data, latitude and longitude of the stations are shown in Table 2.10.

**Table 2.10 Hydrological Stations in Project Area.**

Station	River	Location	Latitude (N)	Longitude (E)	Data Available
Thanh My	Vu Gia	Quang Nam	15° 46'	107° 50'	1977-2010
Ai Nghia	Vu Gia	Quang Nam	15° 53'	108° 07'	1976-2010
Nong Son	Thu Bon	Quang Nam	15° 42'	108° 02'	1977-2010
Giao Thuy	Thu Bon	Quang Nam	15° 49' 30"	108° 09'	1976-2010
Cau Lau	Thu Bon	Quang Nam	15° 51' 43"	108° 17'	1976-2010

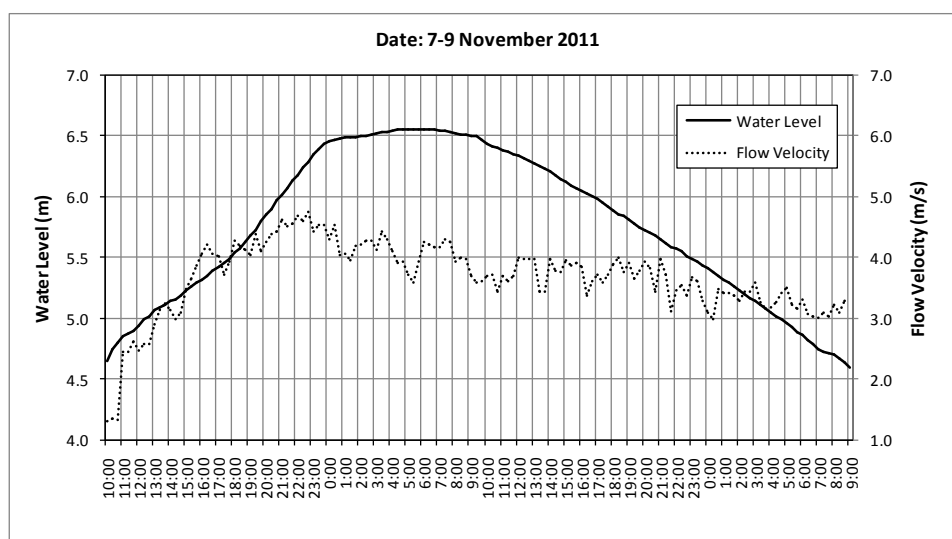
#### (2) River Water Levels and Flow Velocities

The water levels and velocities of flow were observed in 4 major bridges locations in rivers during rainy season of 2011. The daily water levels in rivers have been observed for 2 months during the rainy season. The daily river water levels of Ky Lam Bridge (Thu Bon River), Chiem Son Bridge (Ba Ren River), Tra Bong Bridge (Tra Bong River) and Tra Khuc Bridge (Tra Khuc River) are shown in Figure 2.8. At Ky Lam Bridge of railway in Thu Bon River, the maximum and minimum water levels observed were 6.56 m and 2.02 m, respectively.



**Figure 2.8 Water Levels of Rivers**

Further, water flow velocities in rivers were observed during one high flood of 2011. The maximum river flow velocity observed at Ky Lam Bridge of railway in Thu Bon River was 4.75 m/s (Figure 2.9).



**Figure 2.9 Water Level and Flow Velocity at Ky Lam Bridge**

**(3) Frequency Analysis of Annual Maximum Water Level**

Frequencies of annual maximum water levels of rivers have been analyzed by Hydro Meteorological Center (HMC), Hanoi. The HMC certified design water levels of different probability levels (return periods) of rivers are used for hydrological analysis. The historical records of annual maximum water levels of rivers and fittings of distribution function for frequency analysis of the water level of each station are shown below.

**(a) Ai Nghia**

The historical records of annual maximum water levels at Ai Nghia of Vu Gia River during 1976 – 2010 are shown in Table 2.11. The highest annual maximum water level of 10.77 m was observed in 2009, whereas the lowest annual maximum water level of 7.60 m was observed in 1977.

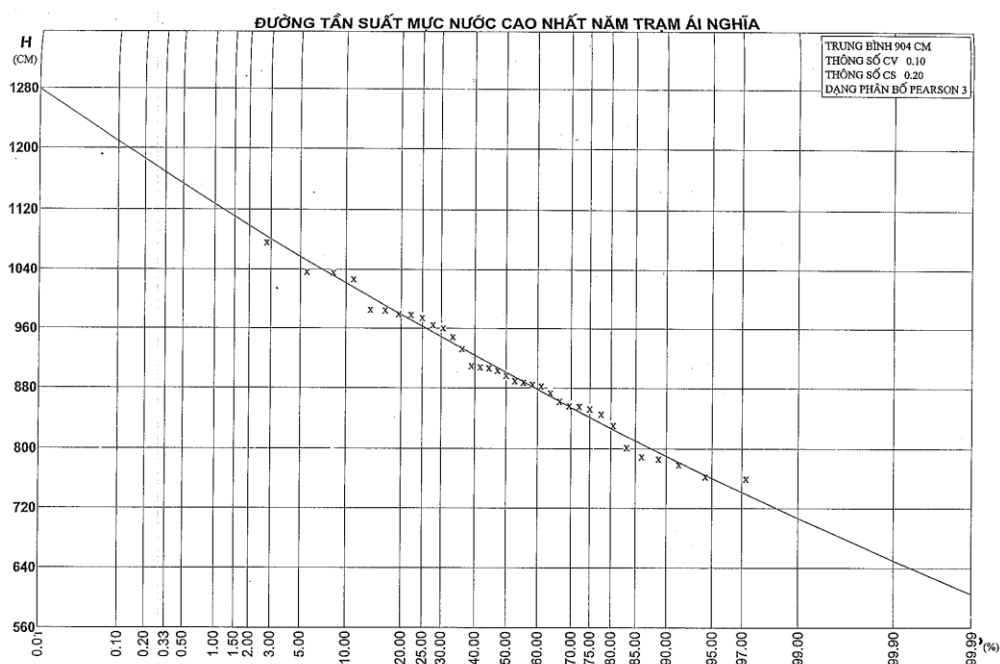
**Table 2.11 Annual Maximum Water Levels of Ai Nghia**

Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)
1976	8.02	1983	9.79	1990	9.85	1997	8.74	2004	9.61
1977	7.60	1984	9.65	1991	8.46	1998	10.37	2005	8.53
1978	8.31	1985	8.83	1992	9.04	1999	10.27	2006	9.75
1979	7.79	1986	9.07	1993	7.90	2000	8.90	2007	10.36
1980	9.86	1987	7.63	1994	8.56	2001	9.49	2008	9.10
1981	9.33	1988	8.88	1995	9.08	2002	7.87	2009	10.77
1982	8.63	1989	8.57	1996	9.80	2003	8.85	2010	8.97

The results of the frequency analysis of annual maximum water levels carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Table 2.12. The certified water levels by HMC are 11.27 m and 10.57 m for 1% and 5% exceeding probability levels, respectively. The fitting of distribution function with observed annual maximum water levels is shown in Figure 2.10.

**Table 2.12 Design Water Level Ai Nghia**

Recurrence Probability Level		HMC Certified Water Level (m)
Year	% P	
2	50.0	9.01
3.3	30.0	9.49
5	20.0	9.79
10	10.0	10.21
20	5.0	10.57
33.3	3.0	10.81
50	2.0	10.99
100	1.0	11.27
200	0.5	11.53



**Figure 2.10 Frequency Analysis of Annual Maximum Water Level of Ai Nghia**

**(b) Giao Thuy**

The historical records of annual maximum water levels at Giao Thuy of Thu Bon River during 1976 – 2010 are shown in Table 2.13. The highest annual maximum water level of 9.75 m was observed in 2009, whereas the lowest annual maximum water level of 7.14 m was observed in 1982.

**Table 2.13 Annual Maximum Water Levels of Giao Thuy**

Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)
1976	7.91	1983	9.11	1990	9.20	1997	8.04	2004	8.87
1977	7.36	1984	8.88	1991	7.81	1998	9.41	2005	7.88
1978	7.17	1985	8.38	1992	8.61	1999	9.39	2006	8.03
1979	7.44	1986	8.80	1993	7.55	2000	8.14	2007	9.60
1980	9.40	1987	7.18	1994	8.00	2001	8.69	2008	8.41
1981	8.77	1988	8.28	1995	8.25	2002	7.25	2009	9.75
1982	7.14	1989	7.47	1996	8.93	2003	8.22	2010	8.49

The results of the frequency analysis of annual maximum water levels carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Table 2.14. The certified water levels by HMC are 10.40 m and 9.75 m for 1% and 5% exceeding probability levels, respectively. The fitting of distribution function with observed annual maximum water levels is shown in Figure 2.11.

**Table 2.14 Design Water Level of Giao Thuy**

Recurrence Probability Level		HMC Certified Water Level (m)
Year	% P	
2	50.0	8.31
3.3	30.0	8.75
5	20.0	9.03
10	10.0	9.42
20	5.0	9.75
33.3	3.0	9.97
50	2.0	10.14
100	1.0	10.40
200	0.5	10.64

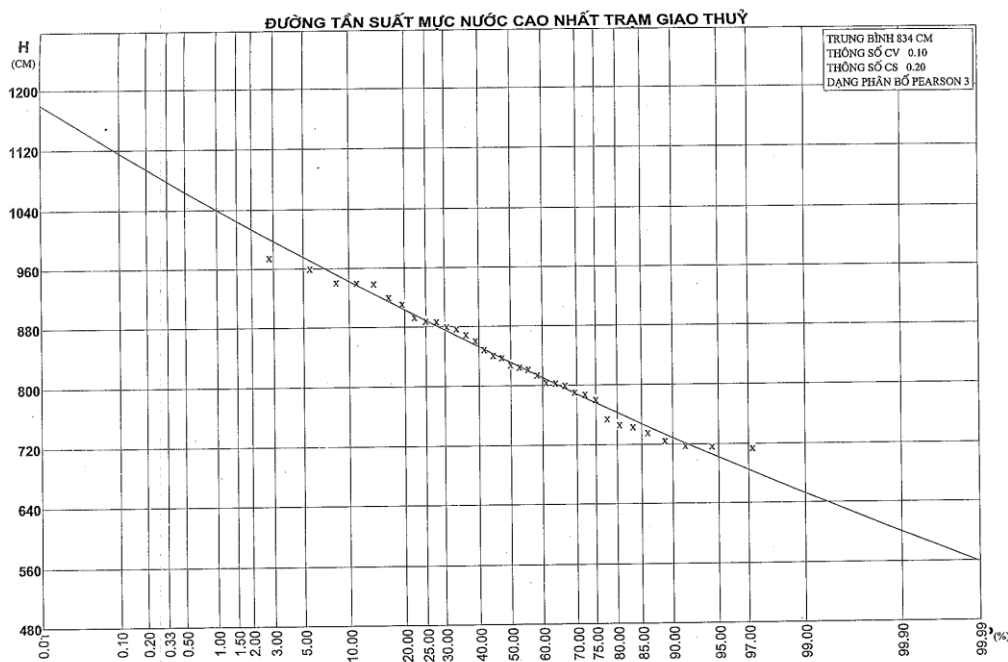


Figure 2.11 Frequency Analysis of Annual Maximum Water Level of Giao Thủy

(c) **Cau Lau**

The historical records of annual maximum water levels at Cau Lau of Thu Bon River during 1976 – 2010 are shown in Table 2.15. The highest annual maximum water level of 5.39 m was observed in 2007, whereas the lowest annual maximum water level of 2.65 m was observed in 1978.

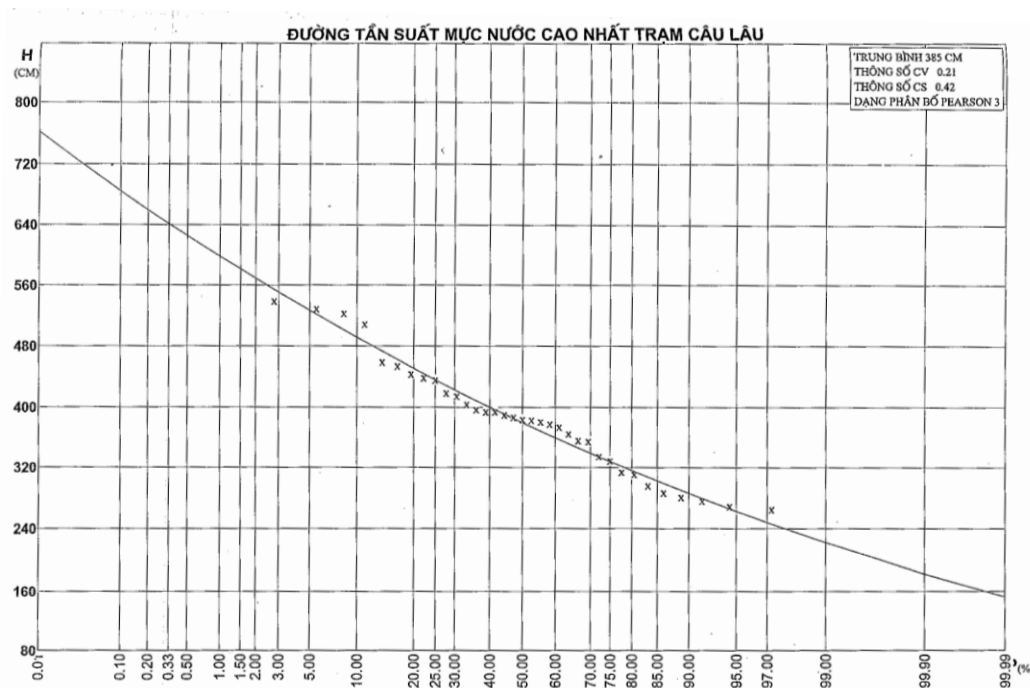
Table 2.15 Annual Maximum Water Levels of Cau Lau

Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)	Year	Max Water Level (m)
1976	3.14	1983	4.36	1990	4.39	1997	3.81	2004	4.59
1977	2.76	1984	3.97	1991	3.35	1998	5.09	2005	3.56
1978	2.65	1985	3.84	1992	3.94	1999	5.23	2006	3.65
1979	2.69	1986	4.19	1993	3.29	2000	3.83	2007	5.39
1980	4.54	1987	2.87	1994	3.55	2001	4.15	2008	3.94
1981	3.90	1988	3.74	1995	3.87	2002	2.96	2009	5.29
1982	2.81	1989	3.11	1996	4.44	2003	3.78	2010	4.04

The results of the frequency analysis of annual maximum water levels carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Table 2.16. The certified water levels by HMC are 5.98 m and 5.27 m for 1% and 5% exceeding probability levels, respectively. The fitting of distribution function with observed annual maximum water levels is shown in Figure 2.12.

**Table 2.16 Design Water Level of Cau Lau**

Recurrence Probability Level		HMC Certified Water Level (m)
Year	% P	
2	50.0	3.79
3.3	30.0	4.23
5	20.0	4.51
10	10.0	4.91
20	5.0	5.27
33.3	3.0	5.51
50	2.0	5.69
100	1.0	5.98
200	0.5	6.25



**Figure 2.12 Frequency Analysis of Annual Maximum Water Level of Cau Lau**

**(4) Frequency Analysis of Annual Maximum Discharge**

Frequencies of annual maximum discharges of rivers have been analyzed by Hydro Meteorological Center (HMC), Hanoi. The HMC certified design discharges of different probability levels (return periods) of rivers are used for hydrological analysis. The historical records of annual maximum discharges of rivers and fittings of distribution function for frequency analysis of the discharge of each station are shown below.

**(a) Thanh My**

The historical records of annual maximum discharges at Thanh My of Vu Gia River during 1977 – 2010 are shown in Table 2.17. The highest annual maximum discharge of 7,230 m<sup>3</sup>/s was observed in 2009, whereas the lowest annual maximum discharge of 1,290 m<sup>3</sup>/s was observed in 1978.

**Table 2.17 Annual Maximum Discharges of Thanh My**

Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)
1977	1640	1984	5800	1991	1700	1998	7000	2005	3380
1978	1290	1985	1880	1992	3920	1999	4930	2006	4830
1979	1940	1986	3560	1993	1510	2000	4200	2007	6810
1980	5330	1987	2020	1994	2010	2001	3100	2008	2400
1981	4880	1988	2960	1995	4250	2002	1370	2009	7230
1982	2380	1989	1720	1996	6390	2003	4640	2010	2330
1983	5000	1990	5370	1997	3480	2004	3910		

The results of the frequency analysis of annual maximum discharges carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Table 2.18. The certified discharges by HMC are 9,608 m<sup>3</sup>/s and 7,297 m<sup>3</sup>/s for 1% and 5% exceeding probability levels, respectively. The 1% exceeding probability specific discharge of Vu Gia River at Thanh My is 4.698 m<sup>3</sup>/s/km<sup>2</sup> (Table 2.19). The fitting of distribution function with observed annual maximum discharges is shown in Figure 2.13.

**Table 2.18 Design Discharge of Thanh My**

Recurrence Probability Level		HMC Certified Discharge (m <sup>3</sup> /s)
Year	% P	
2	50.0	3342
3.3	30.0	4375
5	20.0	5099
10	10.0	6236
20	5.0	7297
33.3	3.0	8048
50	2.0	8631
100	1.0	9608
200	0.5	10565

**Table 2.19 Specific Discharge of Vu Gia River**

Station	Catchment Area (km <sup>2</sup> )	1% Discharge (m <sup>3</sup> /s)	1% Specific Discharge (m <sup>3</sup> /s/km <sup>2</sup> )
Thanh My	2045	9608	4.698

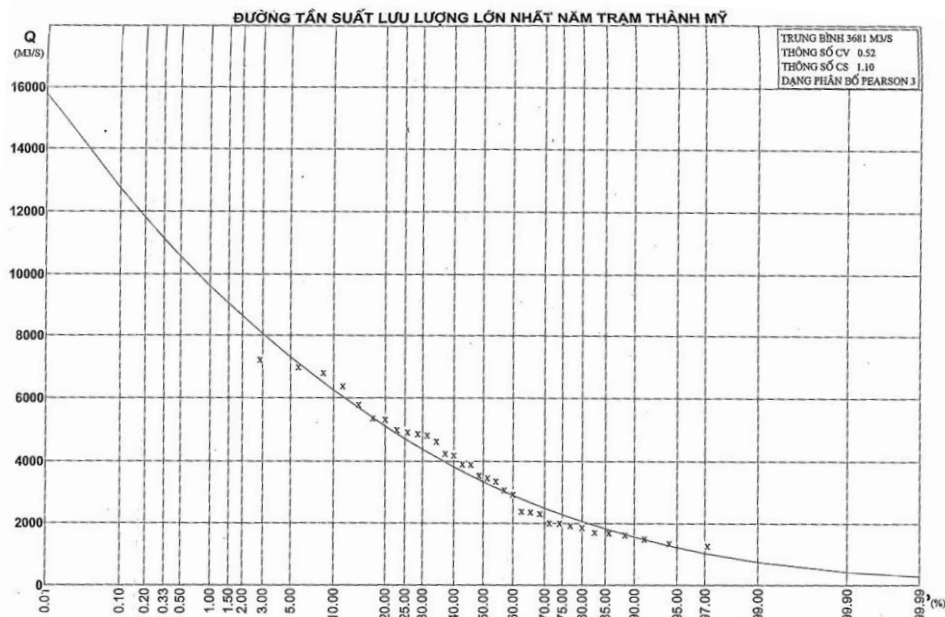


Figure 2.13 Frequency Analysis of Annual Maximum Discharge of Thanh My

(b) Nong Son

The historical records of annual maximum discharges at Nong Son of Thu Bon River during 1977 – 2010 are shown in Table 2.20. The highest annual maximum discharge of 10600 m<sup>3</sup>/s was observed in 1998, 1999 and 2007, whereas the lowest annual maximum discharge of 2800 m<sup>3</sup>/s was observed in 1982.

Table 2.20 Annual Maximum Discharges of Nong Son

Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)	Year	Max Discharge (m <sup>3</sup> /s)
1977	4050	1984	7440	1991	3720	1998	10600	2005	6120
1978	3060	1985	5040	1992	6220	1999	10600	2006	5990
1979	3470	1986	10100	1993	4380	2000	6340	2007	10600
1980	6820	1987	3790	1994	6580	2001	6600	2008	6170
1981	5730	1988	4640	1995	5990	2002	4360	2009	9000
1982	2800	1989	3290	1996	7460	2003	6680	2010	8250
1983	7660	1990	7900	1997	6500	2004	9350		

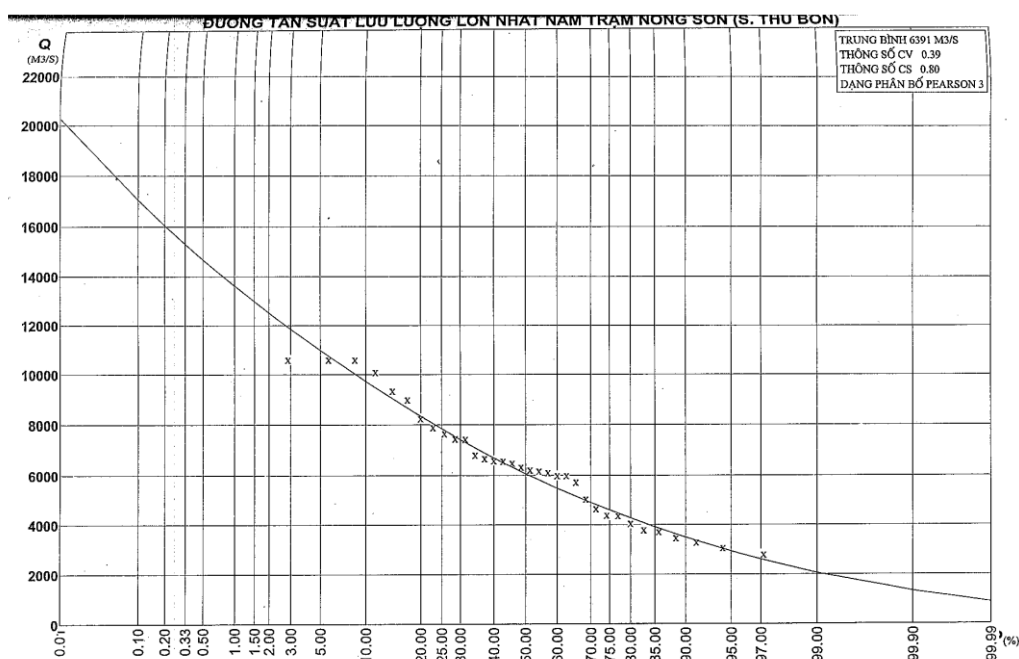
The results of the frequency analysis of annual maximum discharges carried out by the Hydro Meteorological Center (HMC), Hanoi are shown in Table 2.21. The certified discharges by HMC are 13,613 m<sup>3</sup>/s and 10,970 m<sup>3</sup>/s for 1% and 5% exceeding probability levels, respectively. The 1% exceeding probability specific discharge of Thu Bon River at Nong Son is 4.271 m<sup>3</sup>/s/km<sup>2</sup> (Table 2.22). The fitting of distribution function with observed annual maximum discharges is shown in Figure 2.14.

**Table 2.21 Design Discharges of Nong Son**

Recurrence Probability Level		HMC Approved Discharge (m <sup>3</sup> /s)
Year	% P	
2	50.0	6065
3.3	30.0	7417
5	20.0	8328
10	10.0	9714
20	5.0	10970
33.3	3.0	11842
50	2.0	12510
100	1.0	13613
200	0.5	14679

**Table 2.22 Specific Discharge of Thu Bon River**

Station	Catchment Area (km <sup>2</sup> )	1% Discharge (m <sup>3</sup> /s)	1% Specific Discharge (m <sup>3</sup> /s/km <sup>2</sup> )
Nong Son	3187	13613	4.271



**Figure 2.14 Frequency Analysis of Annual Maximum Discharge of Nong Son**

### 2.3.6 Navigational Clearance Requirements

Department of Transport (DOT) of Quang Nam province was referred to get information on navigation clearance requirements of the rivers. The navigation clearance requirements of Ky Lam and Chiem Son bridges are shown as per the general standards of navigation clearance requirements in rivers. The vertical and horizontal navigation clearance requirements of bridges are as shown in Table 2.22. Similarly, general standards for navigation clearance requirements in rivers/canals as per TCVN 5664 – 2009 are shown in Table 2.23. Further, information on 5% daily water levels in the bridges are shown based on the water level observations conducted in the rivers during rainy season of 2011. From the observation of water levels in the rivers, it has been cleared that profile of the bridges will be decided by the high water level of rivers because difference between the high water level and 5% daily water level of rivers become greater than 6.0 m which is the required vertical clearance of the bridges.

**Table 2.23 Navigation clearance requirements of bridges**

Station (KM)	Bridge	River / Canal	River Grade	Vertical Clearance (m)	Horizontal Clearance (m)	5% Daily Water Level (m)	Velocity of Flow (m/s)
17+662	Ky Lam Bridge	Thu Bon	IV	≥ 6.0	≥ 30.0	<4.07	< 1.15

### 2.3.7 Design High Water Level and Hydrologic Requirements

The sufficiency of openings of major bridges for smooth flow of 1% flood water have been checked with consideration that there are no any obstructions in river flow at downstream of bridge. The proposed minimum lengths of the bridges for flow of 1% flood water are shown in Table 2.24. The proposed minimum length of Ky Lam Bridge for flow of flood water is 880 m. However, it should be noted that length of bridge should be determined taking consideration of surroundings topographic conditions and existing river area. The length of the bridge should not be determined only based on discharge capacity of the bridge. The water level with 50% of probability is also calculated for the reference for comparison.

**Table 2.24 Design Water Levels and Proposed Minimum Bridge Openings**

Station	River (Bridge)	Probability :1%				Probability :50%
		Discharge (m <sup>3</sup> /s)	Minimum Bridge Opening (m)	Design High Water Level (m)	Velocity of Flow (m/s)	Design Water Level (m)
KM017+662	Thu Bon (Ky Lam)	23,655	880	9.20 (8.66)*	3.44	6.93
KM020+203	Thu Bon (Chiem Son)		410	9.20 (8.66)*		

( ) \* :In F/S Stage

### 3 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.

Summary of geometric design criteria to be applied for the PKG3A with design speed of 120km/h is given in Table 3.1.

**Table 3.1 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)	26.0	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)	2.0	F/S
		Median Marginal Strip (m)	2 x 0.75	TCVN5729
		Crossfall of Roadway (%)	2.0	TCVN5729
5	Sight Dist.	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
6	Horizontal Alignment	Stopping Sight Distance (m)	230	TCVN5729
		Driver's Eye Height (m)	1.2	TCVN5729
		Height of Object (m)	0.3	TCVN5729
		Horizontal Curve		
		Absolute Minimum Radius of Horizontal Curve (m)	650	TCVN5729
		Desirable Minimum Radius of Horizontal Curve (m)	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
7	Vertical Alignment	Transition Curve		
		Minimum Length for Absolute Minimum Radius (m)	210	TCVN5729
		Minimum Length for Desirable Minimum Radius (m)	150	TCVN5729
		Minimum Length for Radius of 1125 m (m)	125	TCVN5729
		Minimum Length for Radius larger than 1125 m (m)	R/9	TCVN5729
		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 Se<1%	1.0	TCVN5729		

Design Elements		Type/Value	Remarks	Reference
	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

#### 4 Typical Cross Sections

Typical cross section was proposed based on review of typical cross section in F/S and examination by the consultant as mentioned in chapter 4.1 and 4.2. However, examination of narrowing from the proposed typical cross section was requested by project authority and other concerned project stakeholders as mentioned in chapter 4.3. Conclusion of the examination of typical cross sections is summarized in chapter 4.3.

##### 4.1 Review of Typical Cross Section in F/S

Cross section elements for the initial stage and the ultimate stage in the F/S are tabulated in Table 4.1. There are some nonstandard and exceptional values from TCVN5729-1997.

**Table 4.1 Cross Section Elements in Initial and Ultimate Stages (F/S)**

Cross Section Elements	F/S																	
	Initial Stage									Ultimate Stage								
	Earthwork Section			Bridge Section			Tunnel Section			Earthwork Section			Bridge Section			Tunnel 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)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)	
Median	1	<u>2.00</u>	2.00	1	2.00	2.00				1	<u>2.00</u>	2.00	1	2.00	2.00			
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50	1	0.75	0.75	2	0.75	1.50	2	0.75	1.50	1	0.75	0.75
Traveled Way (Number of Lanes)	4	3.75	15.00	4	3.75	15.00	2	3.75	7.50	6	<u>3.50</u>	21.00	6	<u>3.50</u>	21.00	3	<u>3.50</u>	10.50
Traveled Way Long Bridge (L>100m)													6	<u>3.50</u>	21.00			
Paved Shoulder include Marginal Strip (Outer)	2	3.00	6.00	2	3.00	6.00	1	3.25	3.25	2	3.00	6.00	2	<u>0.25</u>	0.50	1	<u>0.25</u>	0.25
Earthen Shoulder	2	<u>0.75</u>	1.50							2	<u>0.75</u>	1.50						
Parapet, Service Space				2	0.75	1.50							2	0.50	1.00			
Pedestrian way							1	1.25	1.25							1	1.25	1.25
Total			26.00			26.00			12.75			32.00		100m>	26.00			12.75
														100m<	26.00			

Note: Underlined and italic bold values are nonstandard and exceptional cases.

##### (1) Evaluation

The consultant reviewed the typical cross section in the F/S and evaluated as follows:

##### (a) Noncompliant with Standard Values

Some cross section elements are nonstandard or exceptional value from TCVN5729-1997 as shown in Table 4.2. Noncompliant values are adopted in width of traveled way and marginal strip which are directly affected to driving safety and comfort. Therefore, reformulation of the typical cross sections shall be considered to minimize negative impact on safety and driving comfort.

**Table 4.2 Noncompliant Cross Section Values with TCVN5729-1997**

Category	No.	Corresponding Cross Section Element	
		Initial Stage	Ultimate Stage
Nonstandard	1-a	Median (Earthwork)	Median (Earthwork)
	1-b	--	Traveled Way (Earthwork, bridge (L<100m), Tunnel)
	1-c	--	Paved Shoulder (Bridge, Tunnel)
	1-d	Earthen Shoulder (Earthwork)	Earthen Shoulder (Earthwork)
Exceptional	2-a	--	Traveled Way (bridge(L>100m))

**(b) Unclear Stage Construction Plan for Initial Stage**

As shown in Table 4.2, most of the noncompliant cross section values are applied on the ultimate stage and those values has not explained enough in the F/S.

To prepare future expansion without reconstruction of structures built in initial stage, typical cross section in ultimate stage should be confirmed to provide design condition for stage construction of expressway structures as explained below:

**(i) Mainline Bridge**

Planning of the typical cross section shall be taken into account the availability of widening by type of superstructure. Adoption of exceptional value for PC Box Girder Bridge section can be examined with consideration of minimum traffic safety requirement.

**Table 4.3 Expandability of Bridges**

Girder Type	Widening	Remarks
PC Box Girder	Difficult	Construction of widening is rather complicated and costly comparing with PC-I girder and PC Super T girder due to complex structural characteristic.
PC I Girder	Available	
PC Super T Girder	Available	

- Abutment & Pier: Widening of abutment and pier are needed to support widened superstructure.
- Foundation: Widening of foundation is needed to support widened superstructure.
- Appropriateness of site condition for widening in ultimate stage shall be confirmed.

**(ii) Flyover Bridge**

- Abutment: Position of abutment shall be considered for widening of mainline in ultimate stage.

**(iii) Cross fall**

- Shoulder: Shoulder cross fall shall be 2% instead of 4% to mitigate pavement reconstruction volume in the ultimate stage. Shoulder cross fall shall be same as super elevation grade instead of 4% to mitigate pavement reconstruction volume in the ultimate stage.

**4.2 Examination of Cross Section Elements of Throughway**

**(1) Basic Policy**

In case nonstandard and exceptional narrowing values are compelled to apply on cross section values, level of negative impact on safety and driving comfort shall be minimized. In general, relation between the cross section elements and level of negative impact, and adaptability for narrowing are summarized in Table 4.4 Narrowing shall be applied in consideration of the narrowing adaptability. The consultant recommends that travelled way and marginal strip shall not be narrowed without special reason.

**Table 4.4 Narrowing Impact and Flexibility for Narrowing**

Cross Section Elements	Level of Negative Impact		Narrowing Adaptability
	Safety	Driving Comfort	
Travelled Way	Large	Large	Low
Marginal Strip	Large	Medium	Low
Paved Shoulder (except marginal strip)	Medium	Small	Middle
Median	Medium	Small	High
Earthen Shoulder	Small	Small	High

**(2) Examination Result**

Since the Danang-Quang Ngai Expressway is primary arterial to support regional economical and industrial activities and being developed to provide high speed transit service (design speed 120km/h), the Danang-Quang Ngai Expressway shall be fulfilled high traffic function and high traffic safety. The Consultant examined values of the cross section elements for the nonstandard and exceptional value proposed in the F/S as shown in Table 4.5:

**Table 4.5 Examination Results for the Cross Section Elements and Recommendations**

Cross Section Elements				Major Function (Traffic/Spatial)	Recommended Value
1-a	Median (Earthwork , Mound Type)	TCVN5729	3.0m	<b>Traffic</b> - Directional traffic separation for accident prevention - Glaring mitigation for accident prevention <b>Spatial</b> - Space for guard separator (0.8m~1.0m) - Space for planting (0.5m~1.5m) - Space for bridge pier (~1.0m) - Lateral clearance (0.3m×2)	2.0m
		F/S Value	2.0m		2.0m width fulfills necessary functions and reduce project cost.
1-b	Traveled Way (Earthwork , bridge (L<100m), Tunnel)	TCVN5729	3.75m	- Provide appropriate traveled way width to conform necessary width for vehicle regulation and vehicle passage, as well as vehicle speed. (3.75m)	3.75m
		F/S Value	3.50m		Frequent width change on the expressway shall be avoided. 3.75m width of carriage way shall be provided to ensure level of service and traffic safety.
1-c	Paved Shoulder (Bridge, Tunnel ,including marginal strip (outer))	TCVN5729	3.0m	- Accommodate stopped vehicle, emergency vehicle, maintenance operation space (1.25m~3.0m) - Space for indication of traveled way boundary, provision of marginal traveled way for evasive maneuvers (0.75m) - Structural lateral support of pavement (0.25m~0.50m)	3.0m (2.0m) (0.5m)
		(exceptional , Bridge (L>100m), Tunnel)	(2.0m) (0.5m)		(Bridge) 3.0m width of shoulder shall be provided to bridge sections to fulfill necessary functions. However, exceptional value of 2.0m shoulder width is applicable for long bridges to reduce project cost.
		F/S Value	0.25m		(Tunnel) 0.50m width does not fulfill necessary functions independently. However, 0.50m of 1.25m pedestrian

Cross Section Elements				Major Function (Traffic/Spatial)	Recommended Value
					way can be merged into the marginal strip.
1-d	Earthen Shoulder (Earthwork)	TCVN5729	1.00m	<b>Traffic</b> - Pavement and road bed protection (0.5m) <b>Spatial</b> - Space for guard rail, traffic sign and road facilities (0.5m~0.75m)	0.75m
		F/S Value	0.75m		0.75m width fulfills necessary functions and reducing project cost.
2-a	Traveled Way (bridge(L>100m))	TCVN5729 (exceptional)	3.75m (3.50m)	- Provide appropriate traveled way width to conform necessary width for vehicle regulation and vehicle passage, as well as vehicle speed. (3.75m)	3.75m
		F/S Value	3.50m		3.75m width of carriage way shall be provided to ensure level of service and traffic safety.

As a result of the examination, revised value of the cross section elements are proposed by the Consultant as shown in Table 4.6.

As for PC-Box Girder Bridge, the consultant recommends construction of 31.5m wide superstructure in the initial stage, in case if the future widening from 4 lanes to 6 lanes is required to be considered. Construction of widening of the PC-Box Girder is rather complicated and costly comparing with PC-I girder and PC Super T girder.

**Table 4.6 Proposed Cross Section Elements by the Consultant**

Cross Section Elements	D/D (Proposal)																	
	Initial Stage									Ultimate Stage								
	Earthwork Section			Bridge Section			Tunnel Section			Earthwork Section			Bridge Section			Tunnel 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)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	<u>2.00</u>	2.00	1	2.00	2.00				1	<u>2.00</u>	2.00	1	2.00	2.00			
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50	1	0.75	0.75	2	0.75	1.50	2	0.75	1.50	1	0.75	0.75
Traveled Way (Number of Lanes)	4	3.75	15.00	4	3.75	15.00	2	3.75	7.50	6	3.75	22.50	6	3.75	22.50	3	3.75	11.25
Traveled Way Long Bridge (PC-Box)													6	3.75	22.50			
Paved Shoulder include Marginal Strip (Outer)	2	3.00	6.00	2	3.00	6.00	1	3.25	3.25	2	3.00	6.00	2	3.00	6.00	1	<b>0.50</b>	0.50
Paved Shoulder include Marginal Strip (Outer) Long Bridge (PC-Box)													2	<b>2.00</b>	4.00			
Earthen Shoulder	2	<u>0.75</u>	1.50							2	<u>0.75</u>	1.50						
Parapet, Service Space				2	0.75	1.50							2	0.75	1.50			
Pedestrian way							1	1.25	1.25							1	1.25	1.25
Total			26.00			26.00			12.75			33.50			33.50			13.75
													PC-Box		31.50			

Note: Underlined and italic bold values are nonstandard and exceptional cases.

### 4.3 Examination of Median Width of Thoroughway

Narrowing of median was raised by senior highway engineer of WB on joint meeting held on 13<sup>th</sup> February 2012 with participant of WB, VEC, PMUs and the consultant is requested to study narrowing of median.

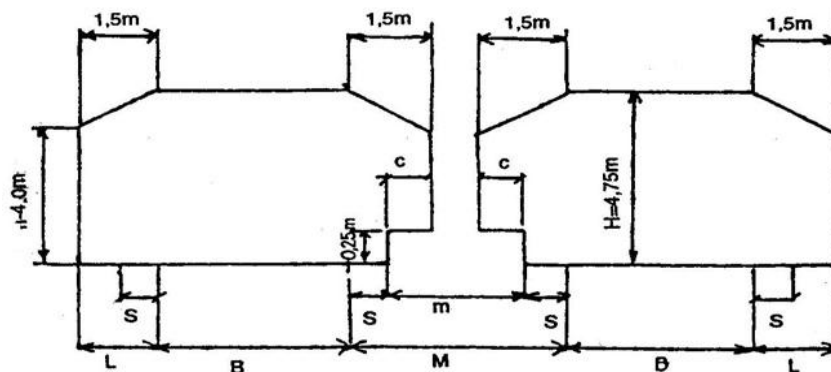
#### (1) General

In general, concrete barrier has the advantage of space saving on median comparing to mound type median with guard rail. The consultant examined introduction of concrete barrier to narrow typical cross section.

**(2) Criteria for Structural Arrangement on Median**

**(a) Lateral and Vertical Clearance (Chapter 4.6\_TCVN5729-1997)**

The lateral and vertical clearances stipulated in TCVN5729 are given in Figure 4.1.



**Figure 4.1 Lateral and Vertical Clearances in TCVN5729-1997**

Where,

m – Median width

S – Marginal strip width

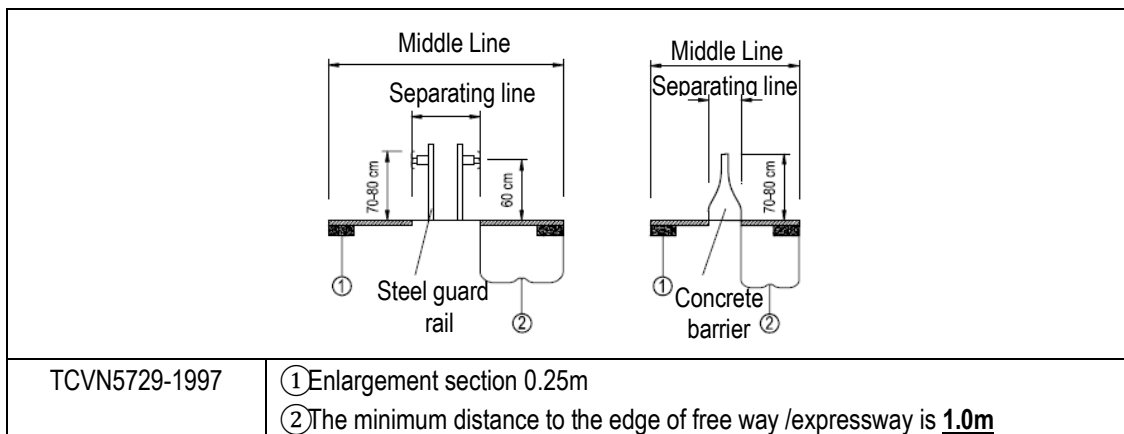
B – Travelled way width

L – Paved shoulder width

C – 0.3 m for Grade 120

**(b) Marginal Strip Width for Concrete Barrier (Chapter 10.1.2\_TCVN5729-1997)**

TCVN5729-1997 stipulated standard marginal strip width for concrete barrier as shown in Figure 4.2.



**Figure 4.2 Marginal Strip Width for Shaped steel and Concrete Barriers**

**(3) Type of Concrete Barrier**

**(a) Technical Standards to be Applied**

AASHTO LRFD Bridge Design Specification stipulates selection criteria for concrete barrier.

**(b) Applicable Type of Concrete Barrier for DQEDP**

Since forecasted number of heavy vehicle in 2035 is more than 3,000 vehicles per day in the DQE Development Project (DQEDP), TL5 class of New Jersey type concrete barrier is selected in accordance with AASHTO LRFD as shown in Table 4.7.

**Table 4.7 Type of Rigid Barrier**

Type	Cross Section
TL-4 (New Jersey)	
TL-5(New Jersey)	

Source : Road Side Design Guide 2002, AASHTO

**(a) Application in the Project**

In accordance with the above technical standards, the following two (2) types of application were prepared for the project as shown in Figures 4.3 and 4.4.

Type 1: For earthwork section (Embankment and Cut)

Type 2: For Bridge section

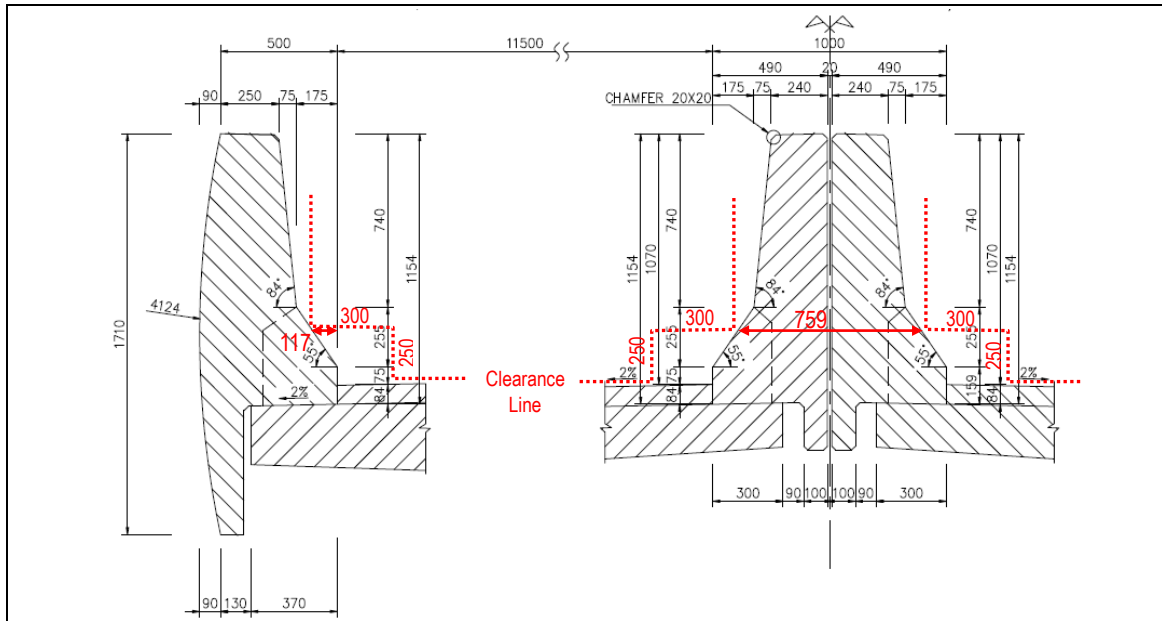


Figure 4.3 New Jersey Barrier (TL-5 for Bridge Section)

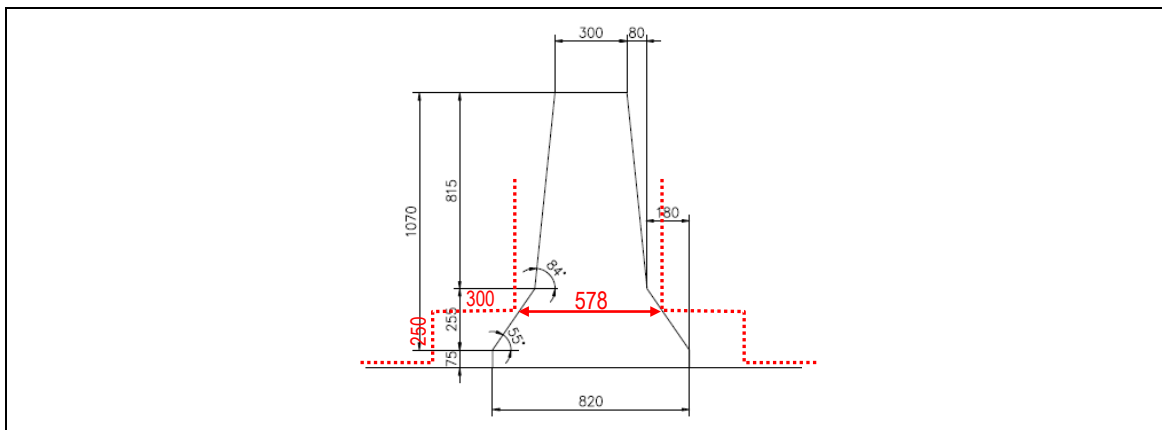


Figure 4.4 New Jersey Barrier (TL-5 for General Section)

#### (4) Examination of Median Arrangement in DQEDP

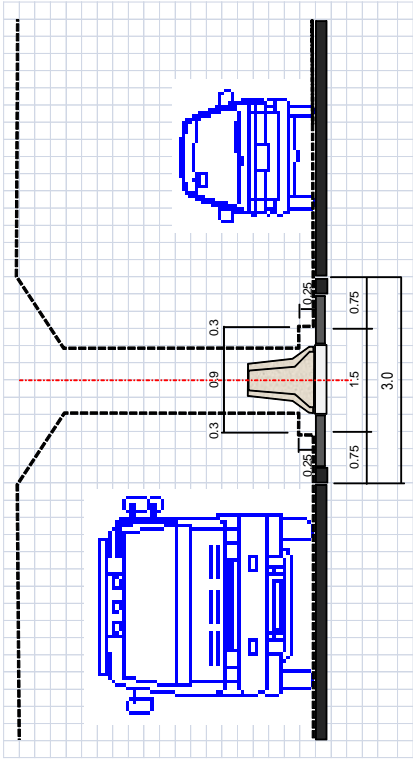
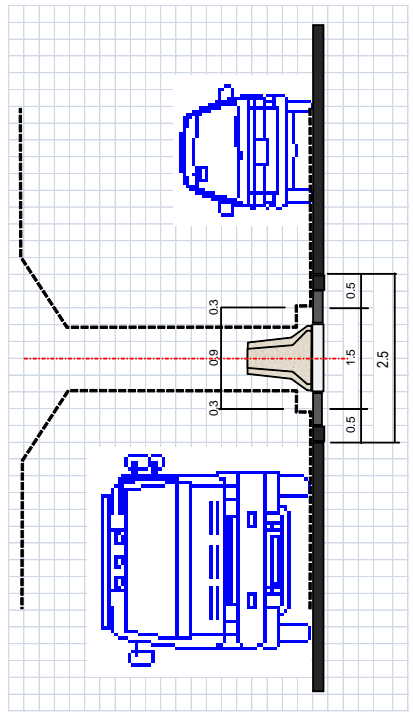
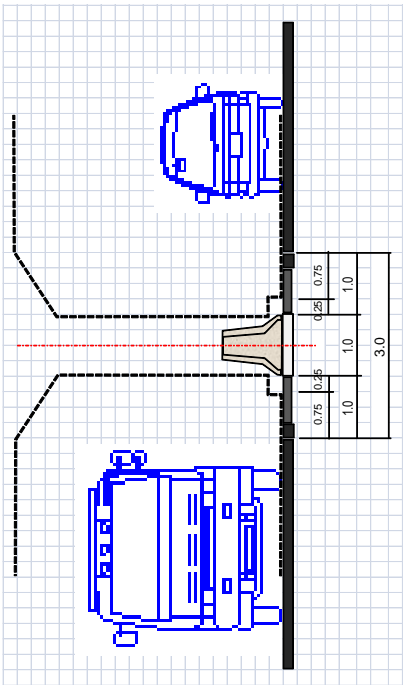
##### (a) Applicable Criteria

Requirements for lateral and vertical clearance stipulated in TCVN5729-1997 should be applied as design criteria of the project.

Design criteria for i) Lateral and Vertical Clearance (Chapter4.6\_TCVN5729-1997) and ii) Marginal Strip Width for Concrete Barrier (Chapter10.1.2\_TCVN5729-1997) are as shown in Table 4.8.

In addition to the requirements of clearance, some space for drainage should be secured and be arranged in the cross section.

**Table 4.8 Comparison of Criteria for Median Arrangement**

Criteria	Earthwork Section	Bridge Section in Ultimate Stage (PC-Box)
A		
B		<p style="text-align: center;">Not Applicable</p>

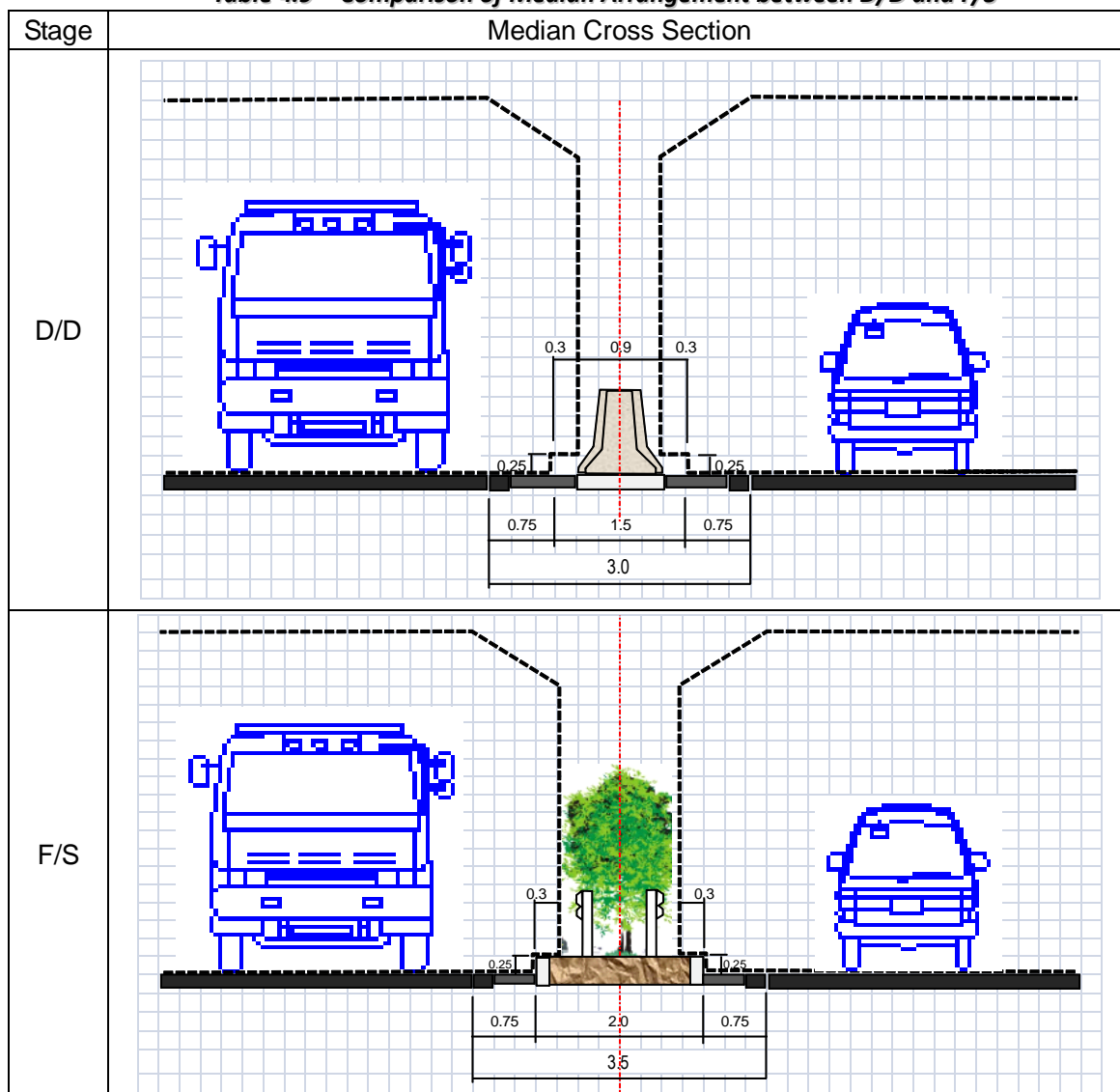
A: Lateral and Vertical Clearance (Chapter 4.6, TCVN5729-1997)  
B: Marginal Strip Width for Concrete Barrier (Chapter 10.1.2, TCVN5729-1997)

**(b) Median Arrangement**

Median is arranged in accordance with lateral and vertical clearance stipulated in TCVN5729-1997, and comparison of the median arrangement result between D/D and F/S is compared in Table 4.9.

0.9m width of separation space between lateral clearance lines is wider than width of the New Jersey barrier shown in Figure 4.3. It is because that some allowable space is needed for arrangement of median at curved section.

**Table 4.9 Comparison of Median Arrangement between D/D and F/S**



**(5) Rearrangement of Cross Section of PC-Box Girder Bridge**

Discussion was made between VEC on 10<sup>th</sup> January 2012 in Hanoi regarding bridge width. It was concluded in the meeting that width of the structure is 26m in the initial stage in accordance with the F/S.

Moreover, TCQM recommended to follow the conclusion of bridge width (26m in initial stage) in Decision 2656/QD-BGTVT based on the result of site checking of the project and reported this recommendation to MOT by letter No. 222/CQLXD-TD1 on 7<sup>th</sup> March 2012. MOT agreed with the recommendation of TCQM and issued letter No. 1619/BGTVT-CQLXD on 9<sup>th</sup> March 2012.

For the above conclusion, the consultant recommended cross section of PC-Box Girder Bridge in ultimate stage as below:

As for design speed on exceptional value of 3.5m traveled way following to cross section arrangement shown in Table 4.1, there is no description in TCVN5279-1997. Meanwhile, standard in

developed country allows 3.5m traveled way width as standard and exceptional values under 120km/h design speed (i.e. JRSO, NEXCO). Along with rearrangement of marginal strips, 0.5m on both sides instead of 0.25m on the left and 0.75m on the right side, to secure lateral clearance of traveled ways as much as possible, 120km/h design speed shall be maintained.

However, 0.5m outer paved shoulder width is still inadequate to secure sufficient traffic safety, concept of lateral clearance at median is introduced into PC-Box Girder Bridge. Therefore, additional 0.25m spaces on both roadside are provided to keep 0.3m lateral clearances on both roadside as shown in Figure 4.5 and additional width of 0.5m in total balanced out the 0.5m narrowing width of median. As a result, total width of PC-Box Girder Bridge is 26m again.

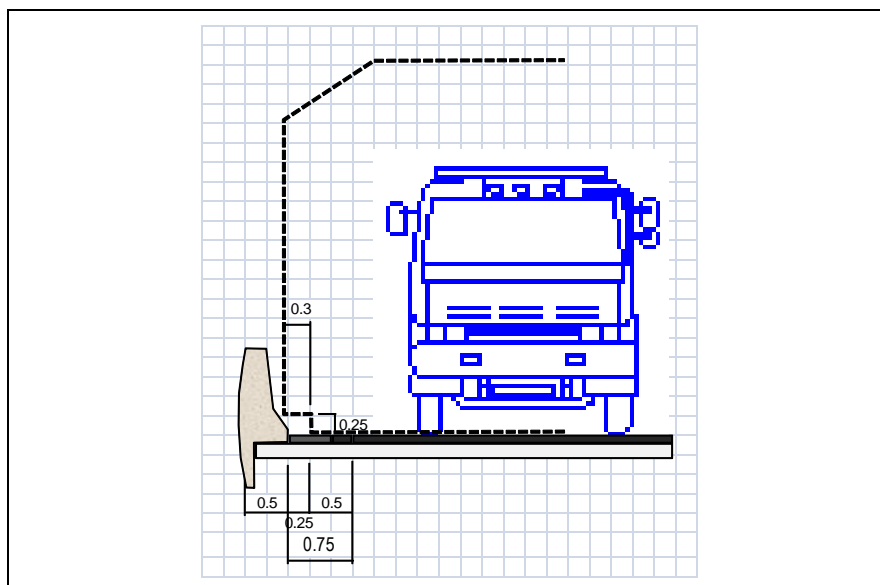


Figure 4.5 Road Side Arrangement for PC-Box Bridge in Ultimate Stage

## (6) Conclusion and Recommendation

As results of the examination, recommended cross section values for earthwork section and bridge section are shown in Table 4.10 and those results are presented in Figure 4.6 and Figure 4.7.

Table 4.10 Total Width of Sections

Cross Section Elements	D/D (Proposal)											
	Initial Stage						Ultimate Stage					
	Earthwork Section			Bridge Section			Earthwork Section			Bridge Section		
	Qty	Width (m)	Total (m)	Qty	Width (m)	Total (m)	Qty	Width (m)	Total (m)	Qty	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
Pedestrian way												
Total			25.50			25.50			33.00			33.00
					PC-Box	26.00					PC-Box	26.00

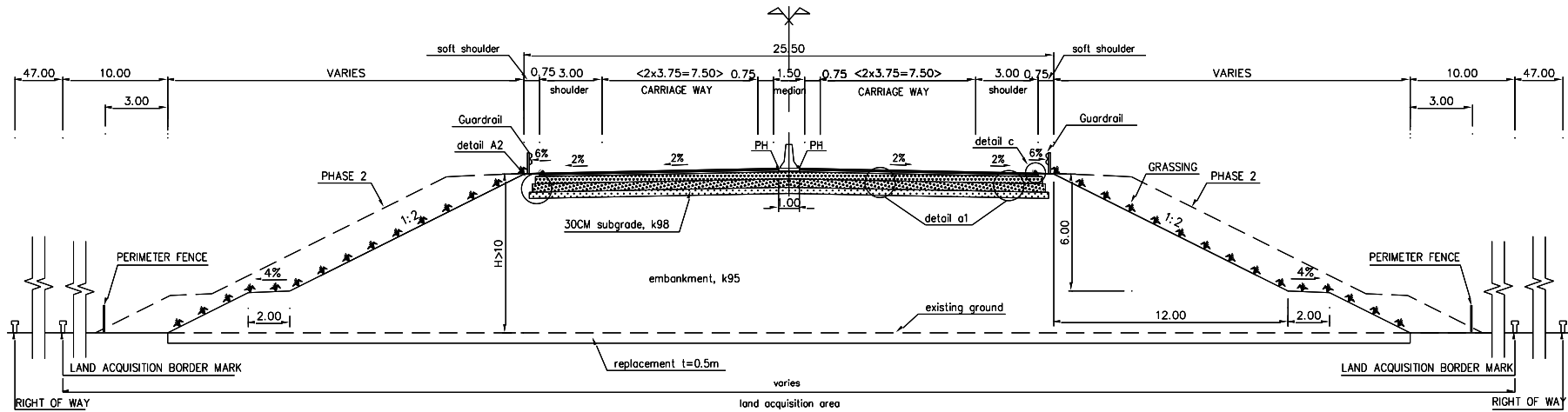


Figure 4.6 Typical Cross Section of Earth Work Section (Initial Stage)

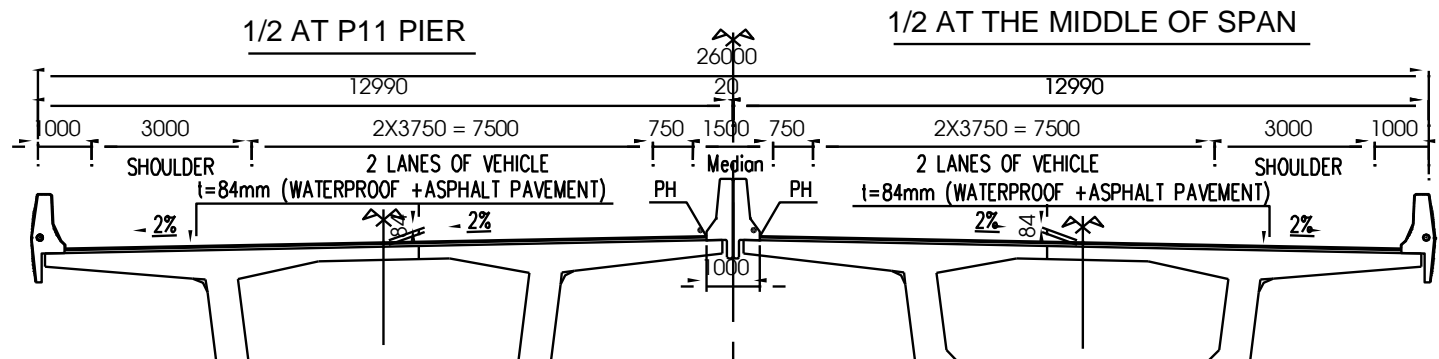


Figure 4.7 Typical Cross Section of Ky Lam Bridge (Initial Stage)

## 5 Geometric Design

### 5.1 Project Alignment in the Previous Study

#### 5.1.1 Horizontal Alignment

Thu Bon River and the existing railway bridge on planning of Ky Lam Bridge are selected as horizontal design control in the F/S. The horizontal alignment of the F/S is properly designed based on the horizontal design controls. The horizontal alignment in the F/S at PKG3A section is shown in Table 5.1.

**Table 5.1 Horizontal Alignment in the F/S**

No.	Type	Length	Radius	A	Start Station	End Station
1	Spiral-Curve-Spiral	450.000m		1341.641m	12+574.291m	13+024.291m
2	Spiral-Curve-Spiral	1321.199m	4000m		13+024.291m	14+345.489m
3	Spiral-Curve-Spiral	450.000m		1341.641m	14+345.489m	14+795.489m
4	Line	3577.228m			14+795.489m	18+372.717m
5	Curve	817.414m	2000m		18+372.717m	19+190.130m

#### 5.1.2 Vertical Alignment

Designing the vertical alignment in the F/S is taken into account the following design controls:

- Design water level at the flood frequency of p=1% (Table 5.2)
- Navigation clearance of Thu Bon River

**Table 5.2 Design Water Level in the F/S**

No.	Station	Water Level (m)		Remarks
		P=1%	The max. of observed water level / years appeared	
26	16+052.81	9.42	-	
27	16+497.27	9.39	-	Ky Long Bridge
28	17+650.00	8.66	-	<b>Ky Lam Bridge</b>
29	20+150.00	8.66	-	Chiem Son Bridge

The vertical alignment of the F/S is properly designed based on the vertical design controls. The vertical alignment in the F/S at PKG3A section is shown in Table 5.3.

**Table 5.3 Vertical Alignment in the F/S**

Curve No.	VC			I1	I2	VCL	VCR	Concave/Convex
	IP	BP	EP					
1	16+362.52	16+315.87	16+409.16	0.4600%	0.1500%	93.3m	30,000	Convex
2	16+991.84	16+898.99	17+084.68	0.1500%	1.7500%	185.7m	12,000	Convex
3	17+661.91	17+315.96	18+007.85	1.7300%	-1.7300%	691.9m	20,000	Concave
4	18+461.13	18+355.98	18+566.30	-1.7300%	0.3700%	210.3m	10,000	Convex

### 5.2 Alignment of the Basic Design

#### 5.2.1 Beginning and End Points

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 is about 180m south from right side river bank of Thu Bon River in Dien Quang commune of Dien Ban district.

#### 5.2.2 Design Controls

##### (1) Horizontal Design Controls

Crucial horizontal design controls on the PKG3A section are Thu Bon River and the existing railway bridge on planning of Ky Lam Bridge as mentioned in the section 6.6.3. As for the horizontal design control on land, there is no crucial design control to make the horizontal alignment realign from the F/S.

## (2) Vertical Design Controls

Designed water level at the flood frequency of  $p=1\%$  and navigation clearance of Thu Bon River are crucial vertical design controls on the PKG3A section as mentioned in the section 6.6.3. There is no other outstanding vertical design control on the section.

### 5.2.3 Geometric Design

#### (1) Horizontal Alignment

The horizontal alignment design of the PKG3A is taken into account the plan of the Ky Lam Bridge. As a result, the horizontal alignment design in the F/S is endorsed by the basic design and long tangent is adopted for the whole section. The modified horizontal alignment for the PKG3A is shown in Table 5.4.

**Table 5.4 Modified Horizontal Alignment (cl\_4b)**

No.	Type	Length	Radius	A	Start Station	End Station
12	Curve	636.597m	20000.000m		15+851.849m	16+488.446m
<b>13</b>	<b>Line</b>	<b>1774.437m</b>			<b>16+488.446m</b>	<b>18+262.883m</b>
14.1	Spiral-Curve-Spiral	220.000m		663.325m	18+262.883m	18+482.883m
14.2	Spiral-Curve-Spiral	597.128m	2000.000m		18+482.883m	19+080.010m
14.3	Spiral-Curve-Spiral	220.000m		663.325m	19+080.010m	19+300.010m

#### (2) Vertical Alignment

The vertical alignment design of the PKG3A is taken into account the Design water level at the flood frequency of  $p=1\%$  and navigation clearance of Thu Bon River. As a result, the vertical alignment design in the F/S is endorsed by the basic design. The modified vertical alignment for the PKG3A is shown in Table 5.5.

**Table 5.5 Modified Vertical Alignment (pr\_3)**

Curve No.	VC			I1	I2	VCL	VCR	Concave/ Convex
	IP	BP	EP					
1	16+700.00	16+550.00	16+850.00	-0.30%	1.20%	300.000m	20000.000m	Concave
2	17+700.00	17+450.00	17+950.00	1.20%	-1.90%	500.000m	16129.032m	Convex
3	18+280.00	18+080.00	18+480.00	-1.90%	0.50%	400.000m	16666.667m	Concave

#### (3) Proposed Alignment

Plan and profile drawing of the PKG3A drafted based on the horizontal and vertical alignment design results is shown in Figure 5.1.

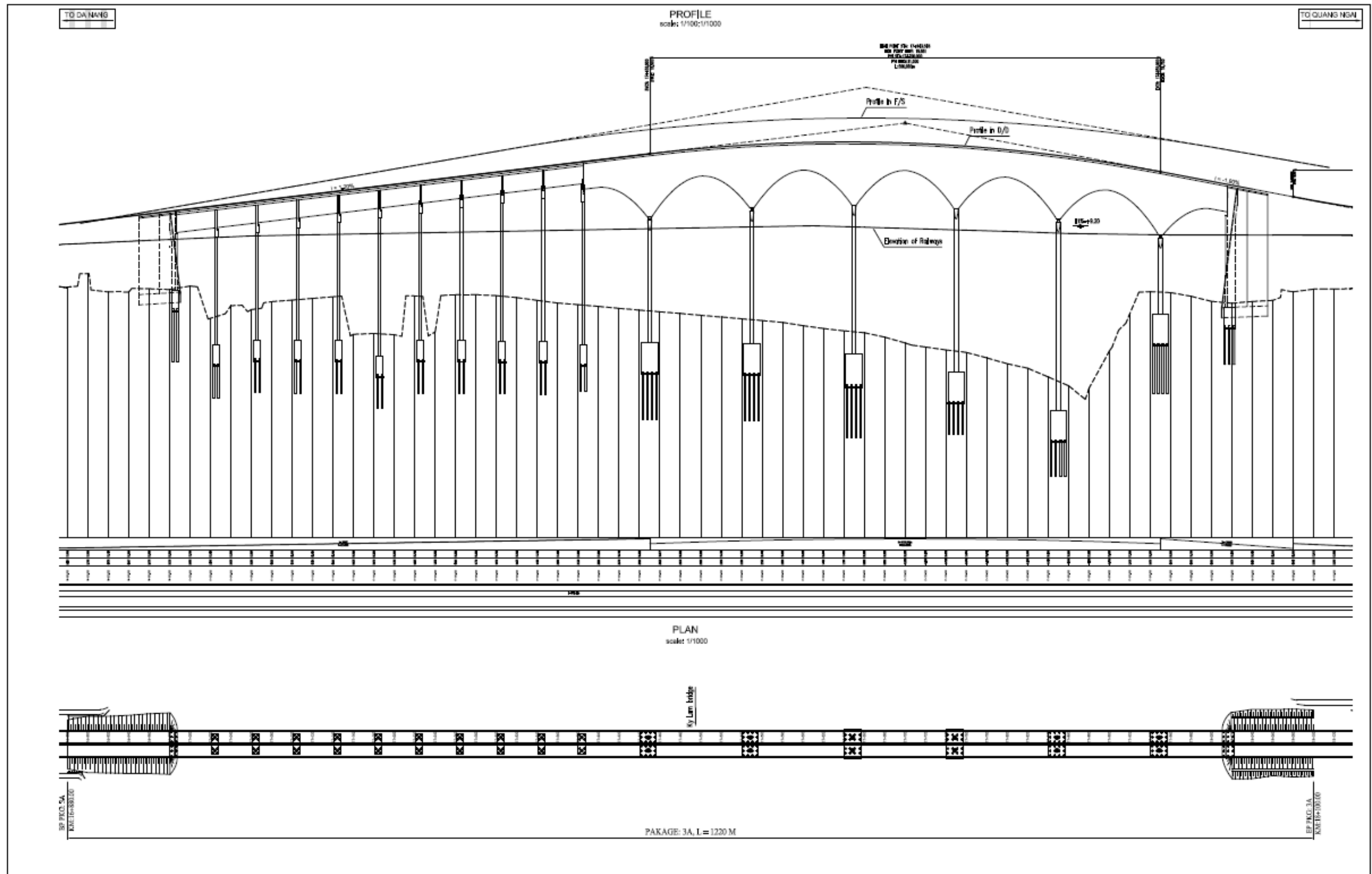


Figure 5.1 Plan and Profile Drawing of the PKG

## 6 Basic Design Study of Ky Lam Bridge

### 6.1 General

#### 6.1.1 Outline of Ky Lam Bridge

Ky Lam Bridge is the main component of the Construction Package 3A of the Da Nang - Quang Ngai Expressway Development Project. Ky Lam Bridge crosses the Thu Bon River at KM017+492 (bridge center) on the Project road in Quang Nam Province (see the Project Location Map). The width of the river on the centerline of the project is approximately 920m (between the existing bank protections).

#### 6.1.2 Alternative Study

An alternative study on bridge structure type of Ky Lam Bridge was carried out and submitted prior to this Basic Design Report. In the Report revision 1 dated December 23, 2011, the six lanes superstructure was recommended by the Consultant, however, VEC instructed the Consultant to apply 1) 26m wide 4 lanes superstructure, and 2) 7 spans continuous PC box girder with a conventional approach bridge (same concept as the F/S), in the meeting held in Hanoi on December 27, 2011. Consequently, 7 spans PC box girder with 4 lanes was additionally evaluated as one of the alternatives in the revision 2 of the Alternative Study Report dated January 4, 2011. Discussions on the Alternative Study Report on Ky Lam Bridge are summarized in the Section 6.7.

### 6.2 Review on Previous Studies

Comments on each technical item in the F/S report are described below:

#### 6.2.1 Cross Sections

##### (1) The F/S Report

The typical cross section of thruway in the F/S was determined to be 26m with 4 lanes for the initial stage. On the other hand, the cross section will be widened to 6 lanes in the ultimate stage according to MOT Decision No. 2656/QD-BGTVT. However, the cross section elements in the ultimate stage were not determined in the MOT Decision.

According to the F/S Consultant, the widening of the bridge structure in the future was not considered and it was planned to reduce the carriageway width from 3.75m to 3.5m without emergency lanes securing 6 lanes in the ultimate stage as shown in Figure 6.1.

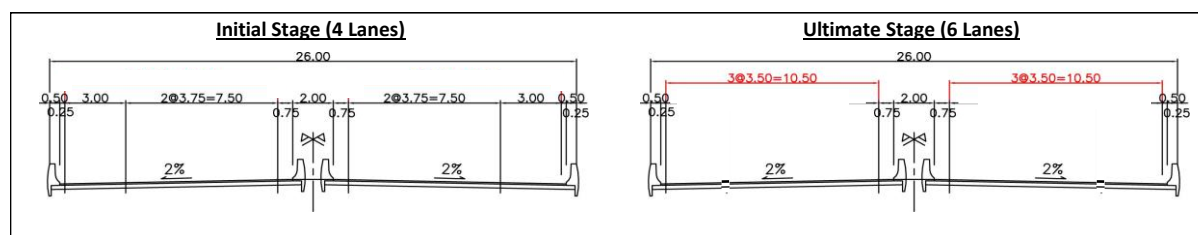


Figure 6.1 Typical Cross Section of Ky Lam Bridge in the F/S

##### (2) Issues and Comments on the F/S

###### (a) Cross Sectional Elements

For bridges longer than 100m such as Ky Lam Bridge, the Consultant recommended constructing a 6 lanes structure, which is 31.0m wide, in the initial stage in consideration of the future widening complying with the standard cross sectional elements, because it is very difficult to widen the bridge structure especially the one with PC box girder.

However, the cross section in the F/S is maintained in the Basic Design as instructed by VEC in the meeting held on December 27, 2011.

The cross sectional elements of the bridges in the F/S are as shown in Table 6.1.

**Table 6.1 Comparison of the Cross Section Elements of Thruway in the F/S**

Cross Section Elements	Instructed by VEC						Recommended by the Consultants					
	Initial Stage			Ultimate Stage			Initial Stage			Ultimate Stage		
	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	2.00	2.00	1	2.00	2.00	1	2.00	2.00	1	2.00	2.00
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50
Carriageway	4	3.75	15.00	6	3.50	21.00	4	3.75	15.00	6	3.75	22.50
Shoulder (Emergency Lane)	2	3.00	6.00	0	-	-	2	3.00	6.00	2	2.00	4.00
Reservation for Future Widening							2	2.75	5.50			
Parapet	2	0.75	1.50	2	0.75	1.50	2	0.50	1.00	2	0.50	1.00
Total			26.00			26.00			31.00			31.00

Note: Shaded cells are non-standard or exceptional values

For some cross sectional elements of thruway in the F/S, non-standard or exceptional values are applied against the TCVN5729-1997 as shown in Table 4. It is noted that reduction of the median (non-standard) and the shoulders (exceptional value for long bridge) are judged to be acceptable fulfilling necessary functions and reducing project cost

Since the Project road is primary arterial to support regional economical and industrial activities and being developed to provide high-speed transport service (design speed 120km/h), the Project road shall fulfill high traffic function and high traffic safety.

### (3) Recommendations

If the total width of the bridge is decided of 26.0m in the initial stage as recommended in the F/S, the Consultant recommends to re-arrange the marginal strips of 0.5m on both sides during the ultimate stage instead of 0.25m on the left and 0.75m on the right side shown in F/S design from traffic safety viewpoints. However, the Consultant strongly recommends the following alternative to the F/S:

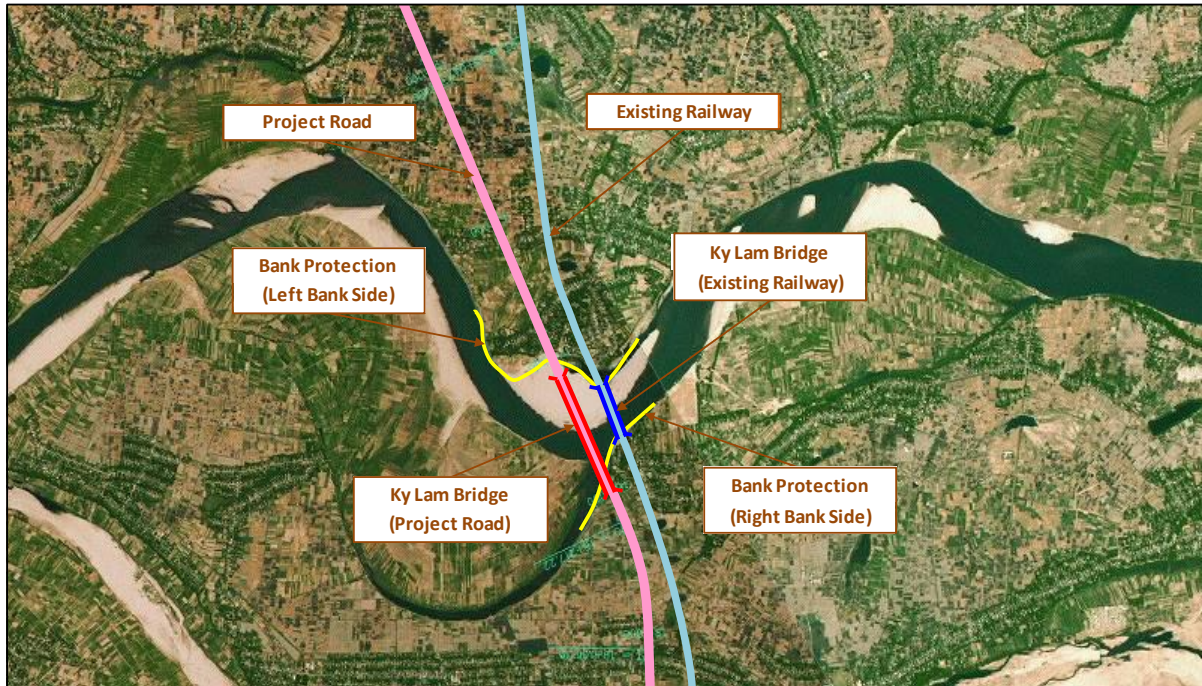
- If the future widening from 4 lanes to 6 lanes is required to be considered, 31m wide superstructures shall be constructed in the initial stage especially for long bridges.

## 6.2.2 Abutment Locations

### (1) The F/S Report

The bridge length for Ky Lam Bridge in the F/S explained that it was considered the secular variation of river channel of the Thu Bon River. However, the abutment at the left bank side was planned within the river area because the existing bank protections is located much left side of the planned abutment as shown in Figures 6.2 and 6.3.

River Channel and Bank Protections in 2005



Secular Variation of River Channel From 2001 to 2008



Figure 6.2 Secular Variation of River Channel in Thu Bon River

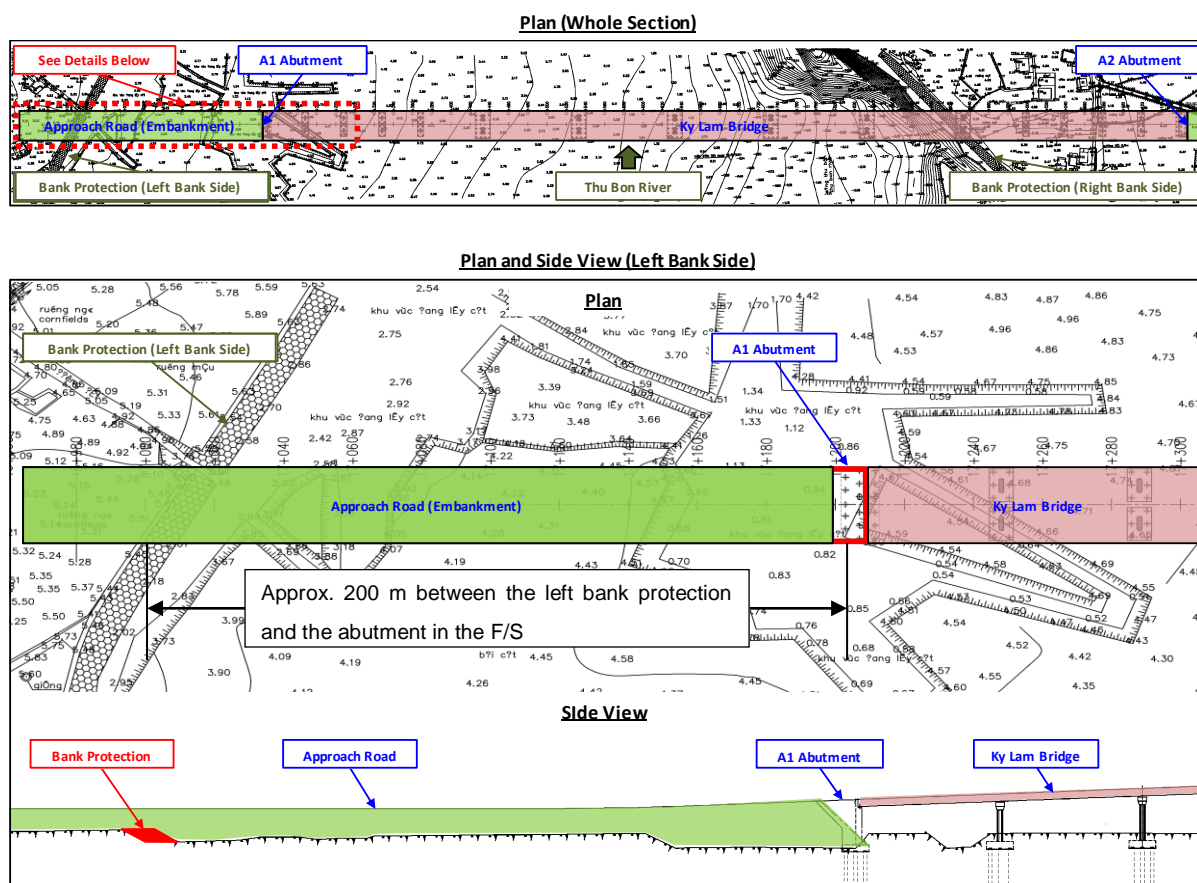


Figure 6.3 Abutment Locations in the F/S Plan

## (2) Issues and Comments on the F/S

### (a) Secular Variation Range of River Channel

It is reasonable to define the length of Ky Lam Bridge in consideration of the secular variation of the river channel of the Thu Bon River. However, the secular variation range of the river channel in the F/S was evaluated based on the existing large scale topographic map (1/50,000).

The Consultant conducted site investigations and hearing to the local residents and it was confirmed that the actual historical secular variation range of river channel in the Thu Bon River is between the existing river bank protections on both sides.

### (b) Abutment Location Regulated by River Administration

The left abutment of Ky Lam Bridge in the F/S was located at the river area, 200 m right side from the existing bank protection, as shown in Figure 6.3.

The Consultant confirmed that the abutment locations of river bridges are not regulated in Vietnam; however, the abutments of Ky Lam Bridge shall be planned outside of the river area to secure the permanent safety flow in terms of the appropriate river administration.

### (c) Required Bridge Opening Length by Inundation Analysis

As mentioned in the Section 2.3.7, the required minimum waterway opening length for the Thu Bon River is 880m. Therefore, the abutments of the bridge shall be located outside of the bank protections (distance of the two bank protections on the centerline of the Project is about 920m) on both sides.

## (3) Recommendations

The Consultant recommends the following modifications and considerations to the F/S.

- The abutments of Ky Lam Bridge shall be located at outside of the river area.
- The bridge length of Ky Lam Bridge shall be longer than the distance between the river banks on both sides.

### 6.2.3 Pier Type and Locations

#### (1) The F/S Report

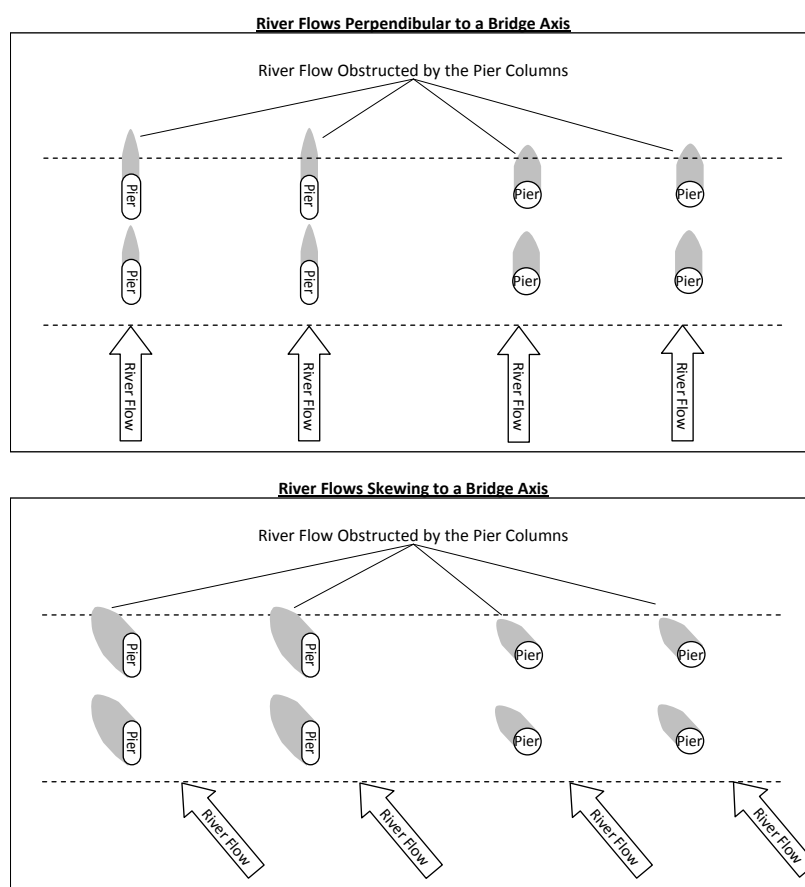
The wall type pier was applied for Ky Lam Bridge in the F/S. According to the F/S Consultant, the impacts to/from the existing railway bridge were not considered for the planning of pier locations in the F/S stage.

#### (2) Issues and Comments on the F/S

##### (a) Considerations for the Secular Variation of River Channel

The wall type pier was applied for Ky Lam Bridge in the F/S; however, this pier type is not preferable for the secular variation of river channel in general.

The pier type shall be properly selected not to be an obstacle to the river flow; otherwise, serious turbulent will be generated at the pier which causes the critical riverbed scouring at its foundation. Therefore, round-shape type piers are recommended for Ky Lam Bridge to allow any direction of river flow as shown in Figure 6.4.



**Figure 6.4 River Flow objected by Wall and Round-shape Piers**

#### (b) Impacts to the Existing Railway Bridge

The impacts to the existing railway bridge were not considered in locating the pier in the F/S.

In general practice in river bridge engineering, 200 m clearance with neighboring bridge is sufficient and no critical impact will be arisen each other.

#### (3) Recommendations

The Consultant recommends the following alternatives to the F/S.

- The round-shape type piers should be applied for Ky Lam Bridge.
- The existing railway bridge is apart from the pier locations of Ky Lam Bridge.

The span arrangement of Ky Lam Bridge was examined in 6.2.5.

### 6.2.4 Navigational Clearance

#### (1) The F/S Report

The navigational clearance of Ky Lam Bridge in the F/S was defined to be 6m\*40m and widened to 6m\*75m in consideration of 30 degree of skew angle at the center span based on the minimum requirement for river class IV in TCVN 5664-1992 as shown in Figure 3.

#### (2) Issues and Comments on the F/S

##### (a) Required Numbers and Location of Navigational Clearance

The navigational clearance of Ky Lam Bridge in the F/S was secured one (1) location at the center span. However, this plan does not consider the secular variation of the river channel of the Thu Bon River.

The Cau Lau Bridge located at the downstream of the Thu Bon River on NH1A Bypass; it seems that the planned location of navigational clearance is on sandbar in the current river conditions due to the variation of river channel as shown in Figure 6.5. In consideration of this unwelcome situation, the navigational clearance of Ky Lam Bridge shall be secured at anywhere in the river section to deal with the secular variation of river channel in the future.

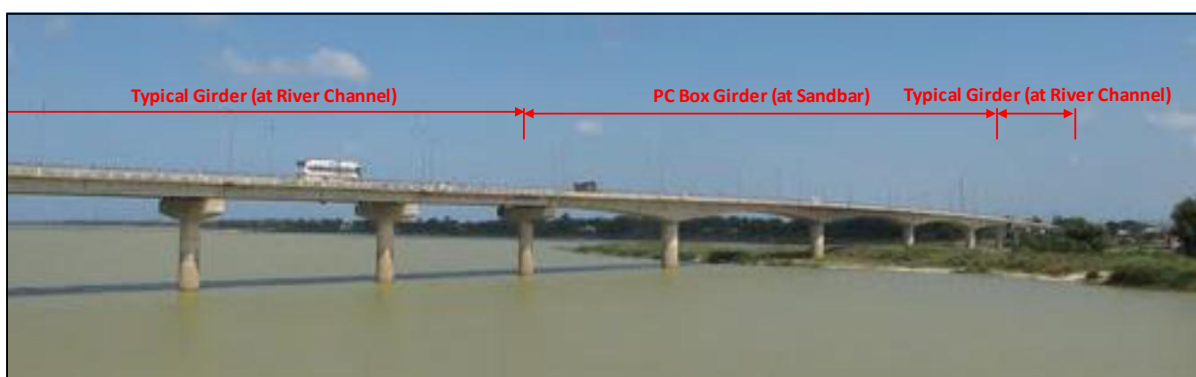


Figure 6.5 Variation of River Channel at Cau Lau Bridge on NH1A Bypass

##### (b) Required Horizontal and Vertical Navigational Clearance

The navigational clearance of Ky Lam Bridge in the F/S was defined as 6m x 40m and widened to 6m\*75m in consideration of 30 degree of skew angle; however, this assumption is not appropriate in consideration of skew angle between the bridge center line and a direction of river flow.

The navigation course in the current river conditions is located near the right bank where the deepest riverbed is observed and is expected to have the most severe skew flow angle which is approximately 45 degree. Therefore, the horizontal navigational clearance should be 60m based on this skew angle.

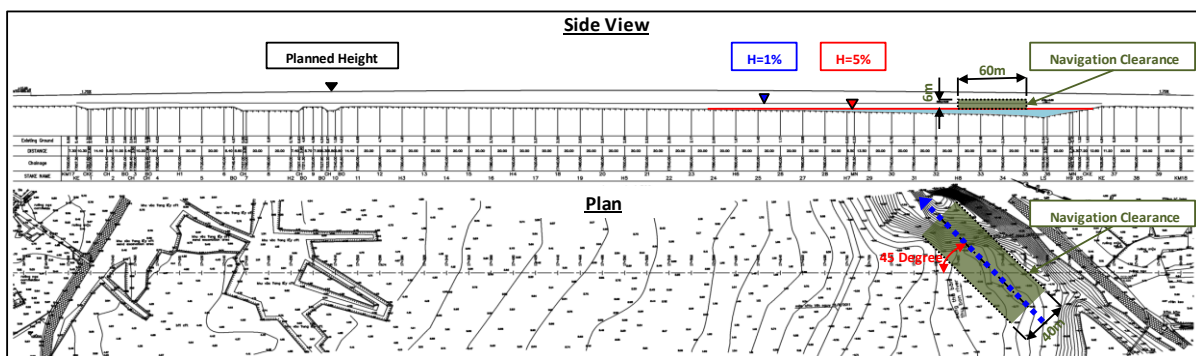


Figure 6.6 Navigational Clearance in the Current River Conditions

#### (3) Recommendations

The Consultant proposes the following alternatives to the F/S.

- The navigational clearance of Ky Lam Bridge should be secured at all the spans inside the river area.

- The navigational clearance of Ky Lam Bridge should be 6m\*60m.

It is noted that TCVN 5664-1992 was applied for the technical standard for navigational clearance in this study. The bridge plan will be updated and finalized in accordance with the inundation analysis results as well as TCVN 5664-2009 and will be reported as a part of Basic Design Report (Civil, PKG3A).

### **6.2.5 Span Arrangement**

#### **(1) The F/S Report**

The span arrangement of Ky Lam Bridge in the F/S is shown in Table 1.3. Followings are confirmed by the F/S Consultant:

##### **(a) The Main Span**

The main span of Ky Lam Bridge was determined based on the location of existing river channel. To select the superstructure type, constructability was prioritized and PC box girder was selected but not typical girders to reduce the number of substructures and their foundations in the river.

The main span length was considered from 70m to 130m based on the economical span lengths for PC box girder in Vietnam. In consideration of adjustability to the length of existing river channel, 100 m long span was selected.

##### **(b) The Approach Span**

The approach span of Ky Lam Bridge was defined as remaining section apart from the main span. The economic aspect in relation to the constructability at onshore was prioritized in the selection of the superstructure type

PC Super Tee girders with 40m in span length were selected by the following reasons:

- The girders are expected to be fabricated at the construction yards in consideration of the unfavorable transport access conditions from factories to the construction site.
- The equipment cost for casting PC super tee girder is higher than other typical girders; however, in case of large number of girders, the total cost is lower than the other typical girders.
- The span length of PC super tee girder (40m) is the longest in typical girders and the total construction cost can be reduced by small number of substructures and foundations.

#### **(2) Issues and Comments on the F/S**

##### **(a) The Required Span Length**

The span length of Ky Lam Bridge shall be more than 50m for all the spans to satisfy the required horizontal navigational clearance as explained in 6.6.3.

##### **(b) The Optimum Span Length**

The economical span length and bridge type was examined based on relevant projects, general practices and hearing from relevant organizations in Vietnam. In case the span length is required to be more than 50m, PC box girder with 70m to 130m length is the most economical solution as shown in Table 6.2 in the following pages.

#### **(3) Recommendations**

The Consultant recommends the following alternatives to the F/S.

- The span length of Ky Lam Bridge is considered to be 70m to 130m for whole river section between the existing bank protections.

### **6.2.6 Abutments**

The embankment height of approach roads of Ky Lam Bridge in the F/S was planned to be 12m and the inverted T-shape type abutment with 14m in height was applied. .

The inverted T-shape abutment is advantageous if its height is less than 15m due to constructability and economic aspects; therefore, the F/S is appropriate. However, the heights of the approach roads and abutments will be re-examined in D/D stage in consideration of boring data.

### **6.2.7 Foundations**

The foundations of Ky Lam Bridge in the F/S is 40m long bored pile with 1.0m to 1.5m in diameter; however, no detail explanation was made in the F/S Report in this regard.

In consideration of the scale of Ky Lam Bridge, the foundation applied in the F/S would be appropriate; however, it shall be re-examined in D/D stage in consideration of geotechnical investigations.

**Table 6.2 Economical Span Length and Bridge Type (Span Length=50m to 200m)**

No.	Span Length	Girder Type	Outline Drawing	Main Features	Construction Cost
1	50m to 70m	PC Box Girder (Constant Height)		<ul style="list-style-type: none"> <li>- A stationary supporting or incremental launching method up to 60m in span length, and stationary supporting or cantilever method from 60m to 70m in span length are generally adopted as an erection method.</li> <li>- The stationary supporting method is uneconomical since it requires many import materials and temporary pile foundation in a river.</li> <li>- The incremental launching method is uneconomical since it requires many temporary facilities, especially steels.</li> <li>- The cantilever method is uneconomical in this span length since it requires many form travelers.</li> <li>- This span length with the bridge type is uneconomical in Vietnam since it requires many temporary facilities and more number of piers.</li> </ul>	
2	70m to 130m	PC Box Girder (Variable Height)		<ul style="list-style-type: none"> <li>- This span length with this bridge type is popular in Vietnam.</li> <li>- The cantilever erection method is generally adopted for this span length with this bridge type.</li> <li>- Import materials are limited for this span length, bridge type and erection method.</li> <li>- This span length can reduce the number of piers in comparison with No.1 above.</li> <li>- This span length with bridge type is economical in Vietnam because it reduces temporary facilities, import materials and number of piers.</li> </ul>	
3	More Than 130m	PC Extradozed Girder		<ul style="list-style-type: none"> <li>- This bridge type can secure pre-stressing force to negative bending moment efficiently by utilizing PC strands as external cable.</li> <li>- Girder height of this bridge type can be reduced up to 50% in comparison with No.2 above; therefore, the road profile can be lower.</li> <li>- The cantilever erection method is generally adopted for this span length with this bridge type.</li> <li>- This span length with this bridge type is uneconomical since it requires many PC strands for external cable.</li> <li>- This bridge type requires high-technology for pre-stressing and camber control in construction and maintenance works.</li> </ul>	

## 6.3 Design Standards and Criteria

### 6.3.1 General

A report for applicable design standards and criteria were submitted as “Design Criteria (Bridge Design)” dated January 18, 2012 which is attached in Appendix 1.

Fundamental design policies for the Project are explained below:

### 6.3.2 Design Standards

The design criteria for bridge design in the Project were established based on the Specifications for Bridge Design (22 TCN 272-05) with relevant Vietnamese design standards listed in Table 6.3.

**Table 6.3 List of Applicable Bridge Design Standards**

No.	Code	Title	Reference	
			Decision 362 <sup>1)</sup>	Added <sup>2)</sup>
1	22 TCN 272-05	Specifications for Bridge Design	●	
2	TCXDVN 205: 1998	Pile Foundation Design Standard	●	
3	TCXDVN 375: 2006	Design Earthquake Bearing Facilities	●	
4	TCXDVN 356: 2005	Concrete and Reinforced Concrete	●	
5	22 TCN 267-2000	PC Concrete Anchor T13; T15 & D13;D15	●	
6	TCVN 1651: 2008	Steel for Reinforcement of Concrete		●
7	TCXDVN 338: 2005	Steel Structures Design Standard		●
8	ASTM A722	High-strength Steel Bar for Pre-stressed Concrete		●
9	ASTM A416	Seven-wire, Stress-relieved Strand for Pre-stressed Concrete		●
10	TCVN 2737: 1995	Loads and Effects Design Standard		●
11	TCVN 5664-2009	Rules for Technical Classification of Inland Waterways		●

1) : MOT Decision No. 362/QĐ-BGTVT dated on February 20, 2009

2) : Added by the D/D Consultant (Letter No. DQEDD-PMU85-01-12 dated on January 3, 2012)

The design items which are required in 22 TCN 272-05 but not clearly defined in the design standards listed in Table 6.3 are referred to AASHTO LRFD Bridge Design Specifications, Fourth Edition 2007.

### 6.3.3 Design Policy

The design criteria shall ensure the following design policies:

- The design life of 100 years shall be applied for the bridge;
- The importance category of bridge shall be Essential Bridge; and
- The PC components shall be designed as fully pre-stressed (not partially pre-stressed) concrete.

The importance category of bridge is classified into the Critical, Essential and Other Bridges in section 3.10.3, 22 TCN 272-05; however, the definitions of importance category are not clearly mentioned. In the “Commentary to the specifications for Bridge Design 22 TCN 272-05” issued by MOT in December 2004, it is originally referred from AASHTO LRFD and it can be defined as follows.

- **Critical Bridge:** the critical structures must remain open to all traffic after the design earthquake and be usable by emergency vehicles and for security/defense purposes immediately after a large earthquake, e.g., a 2500-year return period event.
- **Essential Bridge:** the essential structures are generally those that should, as a minimum, be open to emergency vehicles and for security/defense purposes immediately after the design earthquake, i.e., a 500-year return period event.

On the meeting among WB, MOT, VEC, PMU85, PMU1 and D/D Consultant dated on January 10, 2012, it was confirmed that the critical roads/bridges are not existed/planned in Vietnam, therefore, the

importance category of bridge shall be Essential Bridge in the Project.

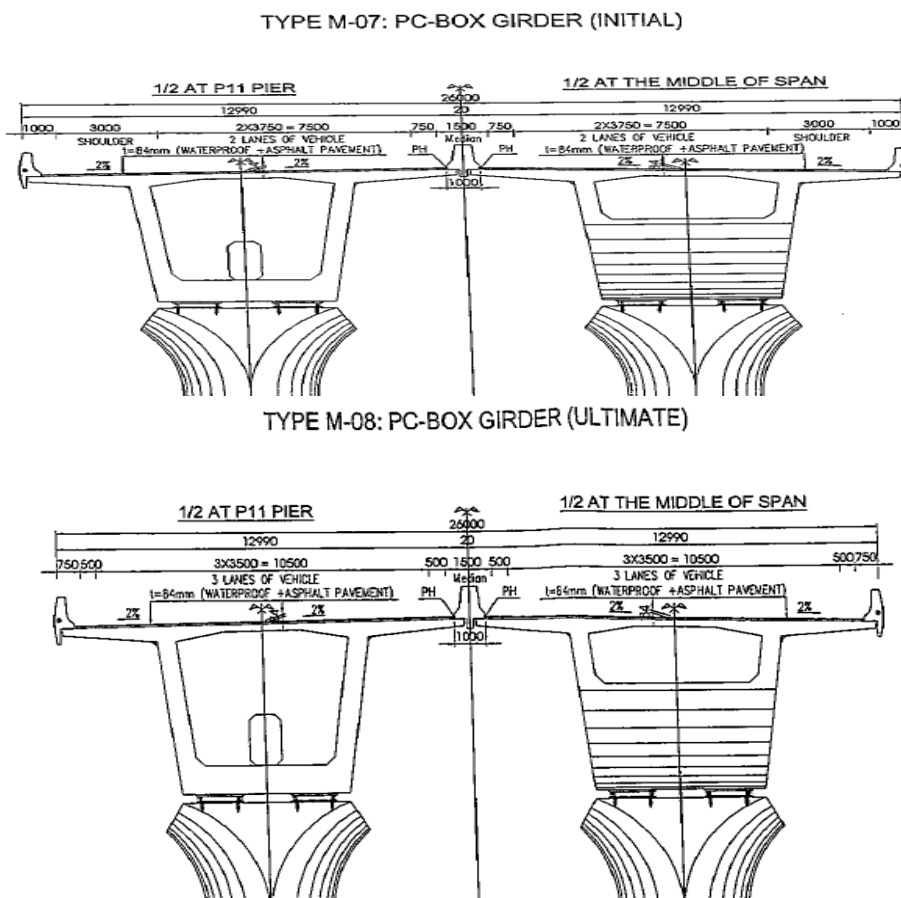
### 6.4 Cross Sectional Elements

Applicable typical cross section of thruway is discussed in “Typical Cross Sections”, which is attached in Appendix 2.

Approved cross sectional elements for Ky Lam Bridge are shown in Table 6.4 and Figure 6.7.

Cross Section Elements	Initial Stage			Ultimate Stage		
	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	1.5	1.50	1	1.5	1.50
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.00
Carriageway	4	3.75	15.0	6	3.5	21.00
Marginal Strip (Outer)						1.00
Shoulder(Emergency lane)	2	3	6.0			
Soft Shoulder						
Parapet	2	1	2	2	0.75	1.50
Pedestrian way						
Total			26			26.00

**Table 6.4 Cross Sectional Elements for Ky Lam Bridge**



**Figure 6.7 Cross Sectional Elements of Ky Lam Bridge.**

#### **6.4.1 Discussion on the Bridge Width**

Cross sectional elements decided through the meetings are shown in Table 6.4 and Figure 6.7. The Consultant recommended 31.0m wide superstructure which can accommodate 6 lanes without applying non-standard values when it is demanded in the future. However, it was concluded that the width of the structure is 26m in the initial stage in accordance with the F/S through a discussion with VEC on January 10, 2012 in Hanoi. If the total width of the bridge is decided of 26.0m in the initial stage as recommended in the F/S, the Consultant recommends to re-arrange the marginal strips of 0.5m on both sides during the ultimate stage instead of 0.25m on the left and 0.75m on the right side shown in F/S design from traffic safety viewpoints.

However, the Consultant strongly recommends the following alternative to the F/S:

- If the future widening from 4 lanes to 6 lanes is required to be considered, 31m wide superstructures shall be constructed in the initial stage especially for long bridges.

### **6.5 Natural Conditions**

#### **6.5.1 Topographical Condition**

The bridge is located at a flat flood plain of the Thu Bon River. It is about 22km from the estuary of the river to the crossing. The river width on the Project center line is about 920m (between existing bank protections on both sides).

From the topographic survey carried out in September, the elevations at the left bank (Da Nang side) and the right bank (Quang Ngai side) on the center line are about +5.5m and +5.0m respectively. The elevations of the river bed vary from +4.7m at the left bank side and -5.5m at the right bank side. The main river channel in September 2011 flows near the right bank. It is noted that a severe local scouring up to -12.5m is observed at the right bank side about 75m downstream from the center line.

#### **6.5.2 River Morphology**

Issues on river morphology of the Thu Bon River are mentioned in the section 6.2. The River has been meandering at the crossing location as shown in the Figure 6.2. The bank protections were placed at the both sides of the crossing and they are continued to the downstream to protect the railway bridge.

#### **6.5.3 Hydrological Condition**

Information on hydrological conditions of Thu Bon River is mentioned in the section 2.3.

#### **6.5.4 Geotechnical Condition**

Boring surveys will be conducted on each and every substructure position after the confirmation of this basic design report by the relevant organizations.

In this Study, geotechnical data in the previous studies were utilized for the Basic Design with referring the ones for Cau Lau Bridge.

### **6.6 Planning Requirements and Conditions**

Conditions for designing Ky Lam Bridge are described below:

#### **6.6.1 Secular Variation of the River Channel**

As explained in the section 6.2, the secular variation of the river channel of the Thu Bon River shall be taken into consideration in terms of following issues:

- Bridge total length should be longer than a potential river width range.
- Span length should be arranged in consideration of the future shift of the river channel.
- Navigational clearance should be arranged for all the spans taking the river channel shifting into account.
- Elevation of the footings of piers should be determined in consideration of the erosion of the river bed.
- Shape of the pier column should be designed in consideration of the variation of the flow direction.

### 6.6.2 Considerations on the Future Widening

To ensure the stability and durability of future widening to six lanes, it is recommended to construct a complete six lanes structure in the initial stage.

### 6.6.3 Required Clearance under the Bridge

Following two criteria are compared and much critical condition will be considered for the design of the elevation of the road profile of the bridge. It is noted that there are no road to be considered or railway crossed by Ky Lam Bridge.

#### (1) Navigational Clearance

The navigational clearance is regulated in the TCVN 5664-2009 as shown in Table 6.5. The design high water level to define the water depth for the bridge crossing is corresponding to 5% at hourly average water level for tidal area while daily average water level for non-tidal area. In accordance with the discussion with the local DOT, the Thu Bon River is classified as IV.

**Table 6.5 Required Navigational Clearances by Class of Waterway**

Class Of Waterway	Horizontal		Vertical
	Canal	River	
I - North	>70	>85	11
II - North	>40	>50	9.5
III - North	>30	>40	9.5
IV - North	>25	>30	6 (5)
V - North	>15	>20	4 (3.5)
VI - North	>10	>10	3 (2.5)

(Source: TCVN 5664 - 2009)

Notes: - North are applicable for cities and provinces in the Northern and Central regions which includes Da Nang, Quang Nam and Quan Ngai.  
- Value in ( ) is not in priority use

#### (2) Freeboard

For setting the required clearance under the bridges, some allowance should be added to the 1% DHWL (freeboard), depending on the existence of driftwoods in the river in accordance with 22 TCN 272 - 05 as shown in Table 6.6:

**Table 6.6 Freeboard under the Bridge from the 1% Design High Water Level**

Category	Freeboard (m)
Without Driftwood	0.500
With Driftwood	1.000

(Source: 22 TCN 272-05)

#### (3) Conclusion

In accordance to the hydrologic surveys as explained in the section “6.2 Hydrological Condition”, above two requirements of clearance were compared and 1% of design high water level with 1.0m of freeboard was applied for this Study as shown in Table 6.7. The elevation of 10.20m will be applied as the minimum elevation at the bottom of the superstructure at any section.

**Table 6.7 Comparison of the Calculation of the Clearance**

Category	Volume	Water Level	Total Elevation	Selection
Navigational Clearance	V:6m, H:30m	4.07m (5%)	10.07m	-
Freeboard	V:1.0m	9.20m (1%)	10.20m	To be applied

### 6.6.4 Existing Structures

There are existing structures to be considered that located in the vicinity of the crossing site as follows:

#### (1) Ky Lam Railway Bridge

Ky Lam Railway Bridge is crossing the Thu Bon Bridge about 200m downstream from the new Ky Lam Bridge on the Project. The bridge is 500m long with 10 spans of 50m steel truss girders built in 2002.

In general practice in river bridge engineering, 200 m clearance with neighboring bridge is sufficient and no critical impact will be arisen to/from each other.



**Figure 6.8 Ky Lam Railway Bridge**

## **(2) Bank Protections**

There are bank protections on both sides of the river at the crossing of Ky Lam Bridge, which is continued to the abutments of the existing Ky Lam Railway Bridge. According to the local residents, main river channel varies between those bank protections at least after the construction of the railway bridge. It is noted that a reconstruction or an improvement will be required for these protections after the completion of the substructures.

### **6.6.5 Lightings**

According to the MOT decision No. 2656/QD-BGTVT dated on September 10, 2010, the lightings on the bridges are required for the bridges longer than 500m. However when TCQM mission had a meeting with VEC, PMU85 and D/D Consultant on 27<sup>th</sup> February 2012, the Mission recommended to MOT that lightings are not necessary on the bridge .but VEC was requested to instruct D/D consultant to study, review locations where the road passes the town ,residential area so that lighting system can be arranged there for safety. D/D Consultant agreed with this idea because the residential areas in the project I not highly developed urbanized area, therefore it should be kept natural lighting by sunshine for vegetation and livestock.

### **6.6.6 Utility Lines on the New Bridge**

According to the F/S, there are no utility to be carried by Ky Lam Bridge except for power lines and telecommunication cables necessary for an operation of the Project expressway.

### **6.6.7 Aesthetical Considerations**

The bridge should be aesthetically fit into the landscape. Simplicity, slenderness and continuity are the major factors to be considered in this basic design of the bridge.

### **6.6.8 Environmental Considerations**

Following environmental considerations shall be taking into account in the basic design of the bridge.

- The road lighting shall be properly arranged not to affect the land in the night.

- Noise, vibration, contamination of the air, water and soil, etc. shall be minimized during the construction.
- The bridge floor runoff shall be collected and deal with, so that they will not enter into water body directly.

## 6.7 Alternative Study

### 6.7.1 Summary of the Alternative Study

Alternative study for Ky Lam Bridge and the report was submitted on December 23, 2011 (Revision 1) taking into account the urgency of the Package 3A. In the meetings with PMU85, VEC and other relevant organizations held on December 24, 2011 in Da Nang, and December 27, 2011 in Hanoi respectively.

After the meeting on December 27, 2011, Revision 2 of the Alternative Report, which includes two more options in accordance with the instruction made by VEC, was submitted on January 4, 2011 (see Appendix 1 for the revision 2 of the Report).

The major comments made by the organizations in the series of meetings and the responses on them by the Consultant are summarized in the Table 6.8.

All the four alternatives in the Revision 2 as well as the F/S plan are summarized in the Table 6.9. The Consultant selected the alternative No.2 originally, however, the alternative 3A (7 spans continuous PC box girder with 10 spans Super Tee girders) was selected by VEC in the meeting on January 10, 2012, as a preferable option.

**Table 6.8 Instructions and Comments from the Relevant Organizations on the Alternative Study Report for Ky Lam Bridge**

Attendants	Date of Meeting	Instructions and Comments	Remarks
PMU85, the Consultant	Dec 24, 2011	<ul style="list-style-type: none"> <li>- The concept of the design is agreed.</li> <li>- The cost for the F/S span arrangement with 6 lanes should be mentioned.</li> </ul>	
VEC, PMU85, PMU1, TEDI, the Consultant	Dec 27, 2011	<ul style="list-style-type: none"> <li>- The width of the bridge shall be 26m as planned in the F/S.</li> <li>- Locations of the both abutments recommended by the Consultant (behind the bank protections) are agreeable.</li> <li>- A cylindrical pier shape recommended by the Consultant is agreeable.</li> <li>- The span arrangement of the superstructure should be same as in the F/S to avoid the cost increase, however, the main spans (100m with PC box girder) can be shifted to accommodate the actual river channel on the right bank side. In this regard, the navigational clearance is sufficient to be secured at a span on the actual river channel.</li> </ul>	The instructions by VEC are reflected in the Revision 2 of the Alternative Study Report dated January 4, 2012.
VEC, MOT, PMU85, PMU1, TEDI, WB, the Consultant	Jan 10, 2012	<ul style="list-style-type: none"> <li>- Super Tee girders shall be applied instead of PC-I girders.</li> <li>- WB commented that further discussion is necessary to decide the width (the number of lanes and width of carriageways).</li> </ul>	The instructions by VEC are reflected in this Basic Design Report.
VEC, PMU85, PMU1, WB, Tthe Consultant	Feb 15, 2012	<ul style="list-style-type: none"> <li>- WB commented that For Major river bridges with box girdler (Ky lam, Chiem Song, Tra Khuc) are recommended to construct 6 lanes in the first stage and for these long bridges, due to economic reasons, emergency lanes can be replaced by right bands.</li> </ul>	2012/2/13-2012/2/15

MOT, VEC, PMU85, PMU1, TEDI, WB, The Consultant	Feb 17,2012	<ul style="list-style-type: none"> <li>- Cross Section: Design and Construction for large bridge (L=100m) need to be carried out one times appropriate to initial and ultimate stages.</li> <li>Lighting: It is agreed with WB suggestion on cancellation of this item for whole section even large bridge except for toll station and service areas in order to save construction and operation</li> <li>Structure of Ky Lam Bridge: It should be studied appropriate for topography and cost saving.</li> </ul>	Wrap-up meeting with WB mission
VEC, PMU85, PMU1, TEDI, The Consultant	28 March 2012	<ul style="list-style-type: none"> <li>- Alternative 3A (10@40m;65m+5@100m+65m) was chosen as being agreed by TCQM,VEC,PMU85,PMU1 at the site checking meeting for DQEP on 28Feb-29Feb.</li> <li>- Consultant is requested to immediately carry out geological survey for detailed design of PKG3A to meet the commencement target of the Project. It is agreed with proposal of Consultant which is narrowing the median from B=2.0m (F/S) to B=1.5m to be appropriate to Standard TCVN5729-97.</li> <li>- Consultant is requested to have explanation for TEDI's comment on relocating A2 abutment toward the right side of Ky Lam Bridge.</li> </ul>	-Submitted Letter to PMU85 <u>Further Study on Structure Option for Ky Lam Bridge</u>

### 6.7.2 Preliminary Study of the Alternative

Four alternatives in total are selected by the Consultant and VEC for comparison in the revision 2 of the Alternative Study Report.

As explained in the Alternative Study Report attached in the Appendix 1, the Consultant selected the Alternative No.2, in terms of the hydrological condition and a securement of the navigational clearance. On the other hand, VEC selected Alternative 3A, mainly due to a limited budget for the Project. The four alternatives as well as the F/S plan are summarized in Table 6.9.

Consultant was requested to have explanation for TEDI's comment on relocating A2 abutment toward the right side of Ky Lam Bridge.

### 6.7.3 Study on A2 Abutment Position

The Abutment A2 in the Alternative2 and Alternative3A is planned at the 70m far from the bank protection by following reasons.

- Pier and Abutment shall not be planned on the bank protection from safety point of view.
- The nearest pier from the right side bank protection shall be located to avoid the most deepest location of this area and Main span with 100m shall be arranged at this area.
- A2 abutment shall be planned at the position 65m far from the Abutment A2 which is necessary span length 65m.

(Refer to Alternative 3A in Table-1 of Appendix 3)

The Consultant carefully reviewed above TEDI's comment and confirmed that relocating A2 Abutment toward the right side is not suitable for the Ky Lam Bridge because of the reason mentioned

In DQEDD-PMU85-156-12 which is attached in Appendix 3.

Finally The Consultant selected the Abutment position of Alternatove3A as a preferable position from the economical and constructability reason.

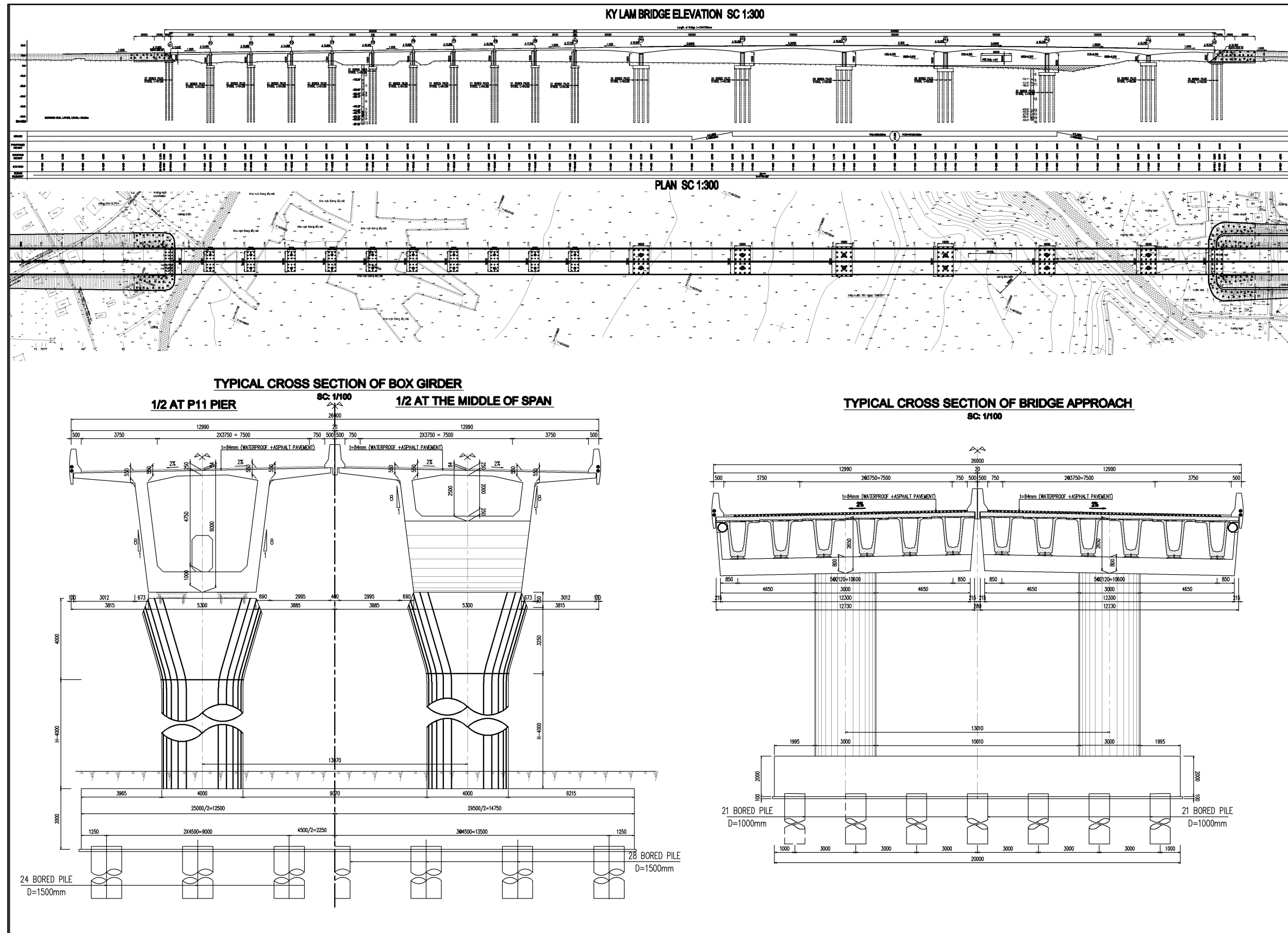
### 6.7.4 Conclusion of the Alternative Study

The alternative 3A was finally selected by the Consultant. A general view of the selected alternative is shown in Table 6.10

Table 6.9 Alternative Plans for Ky Lam Bridge

No	Main Features of the Alternatives	Bridge Width	Navigational Clearance	Pier Shape	Remarks			
F/S		26m	6m x 40m* (6m x 75m in consideration of 30 degree of skew)	Wall type	Reference			
	<table border="1"> <tr> <th>Bridge Length</th> <th>Span Arrangement</th> <th>Main Span</th> <th>Approach Span</th> </tr> <tr> <td>950m</td> <td>4@40m+65m+5@100m+65m+4@40m</td> <td>7 Span Continuous PC Box Girder</td> <td>PC Super Tee Girder</td> </tr> </table>					Bridge Length	Span Arrangement	Main Span
Bridge Length	Span Arrangement	Main Span	Approach Span					
950m	4@40m+65m+5@100m+65m+4@40m	7 Span Continuous PC Box Girder	PC Super Tee Girder					
1		31m	6m x 40m* (6m x 60m in consideration of 45 degree of skew)	Circular type	Selected by the Consultant in Revision 1 of the Alternative Study Report			
	<table border="1"> <tr> <th>Bridge Length</th> <th>Span Arrangement</th> <th>Main Span</th> <th>Approach Span</th> </tr> <tr> <td>952m</td> <td>76m+8@100m+76m</td> <td>10 Span Continuous PC Box Girder</td> <td>-</td> </tr> </table>					Bridge Length	Span Arrangement	Main Span
Bridge Length	Span Arrangement	Main Span	Approach Span					
952m	76m+8@100m+76m	10 Span Continuous PC Box Girder	-					
2		26m	6m x 30m** (6m x 50m in consideration of 45 degree of skew)	Circular type	Selected by VEC A cut out at the end of Super Tee girders are not adopted			
	<table border="1"> <tr> <th>Bridge Length</th> <th>Span Arrangement</th> <th>Main Span</th> <th>Approach Span</th> </tr> <tr> <td>1030m</td> <td>65m+9@100m+65m</td> <td>11 Span Continuous PC Box Girder</td> <td>-</td> </tr> </table>					Bridge Length	Span Arrangement	Main Span
Bridge Length	Span Arrangement	Main Span	Approach Span					
1030m	65m+9@100m+65m	11 Span Continuous PC Box Girder	-					
3A		26m	6m x 30m** (6m x 50m in consideration of 45 degree of skew)	Circular type	- Recommended in Revision 2 of the Alternative Study Report. - PC I girders will be connected longitudinally on the piers to be a continuous girder after the erection of the girders.			
	<table border="1"> <tr> <th>Bridge Length</th> <th>Span Arrangement</th> <th>Main Span</th> <th>Approach Span</th> </tr> <tr> <td>1030m</td> <td>10@40m+65m+5@100m+65m</td> <td>7 Span Continuous PC Box Girder</td> <td>PC I Girder</td> </tr> </table>					Bridge Length	Span Arrangement	Main Span
Bridge Length	Span Arrangement	Main Span	Approach Span					
1030m	10@40m+65m+5@100m+65m	7 Span Continuous PC Box Girder	PC I Girder					
3B		26m	6m x 30m** (6m x 50m in consideration of 45 degree of skew)	Circular type	- Recommended in Revision 2 of the Alternative Study Report. - PC I girders will be connected longitudinally on the piers to be a continuous girder after the erection of the girders.			
	<table border="1"> <tr> <th>Bridge Length</th> <th>Span Arrangement</th> <th>Main Span</th> <th>Approach Span</th> </tr> <tr> <td>1030m</td> <td>10@40m+65m+5@100m+65m</td> <td>7 Span Continuous PC Box Girder</td> <td>PC I Girder</td> </tr> </table>					Bridge Length	Span Arrangement	Main Span
Bridge Length	Span Arrangement	Main Span	Approach Span					
1030m	10@40m+65m+5@100m+65m	7 Span Continuous PC Box Girder	PC I Girder					

Table 6.10 General View of the Selected Alternative 3A



## 6.8 Basic Design

A basic design study was done for the selected alternative in the alternative study explained in the section 6.7.3. General view and dimensions are shown in Table 6.10.

### 6.8.1 Alternative Study of Support Conditions for the PC Box Girder Section

Three types of support conditions that are 1) dispersion rubber bearings, 2) multiple anchorages and 3) rigid frames were compared as shown in Figure 6.9.

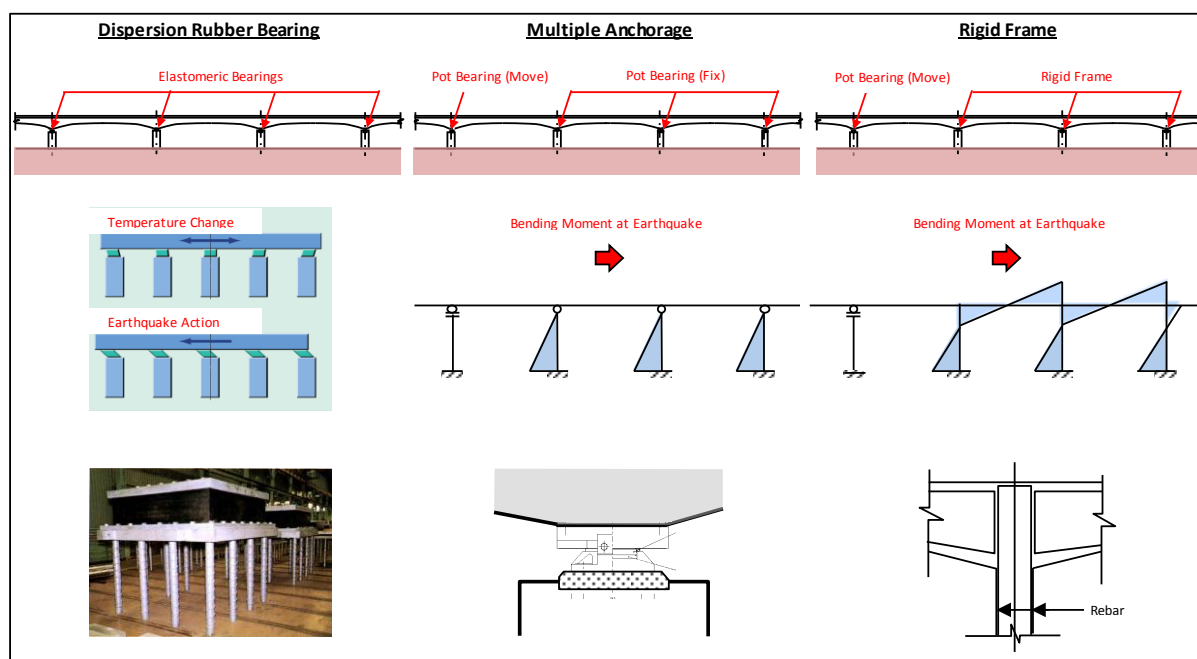


Figure 6.9 Image of Support Conditions

Features of each support conditions are explained below:

#### (1) Dispersion Rubber Bearings

This system requires dispersion rubber bearings for all the supports. Horizontal forces caused by earthquake will be equally dispersed to all the supports. By dispersing the horizontal forces, earthquake resisting performance of bridge is improved. Structurally indeterminate forces at the service condition are reduced due to shear spring. Therefore, the number of continuous spans will be increased. As a result, improvement of earthquake resisting ability, maintainability and driving comfort by decreasing the number of expansion joints will be made.

#### (2) Multiple Anchorages

This system is composed of hinged fix and move support conditions. Pot bearings both fix and move can be utilized. Bending moments caused by horizontal forces are mainly born by piers with fixed support.

In case of soft ground, the above mentioned dispersion rubber bearings may be a cause of a resonance of the structure and the ground, since the bridge may become a long period structure due to the rubber bearings. In such case, the multiple fixed anchorages are suitable. Unbalanced dispersion forces shall be carefully considered when topography and/or geology are complicated.

#### (3) Rigid Frames

This system is a combination of rigid frames and move supports. Horizontal forces are born by piers and superstructure where rigidly connected. Rigid frames are suitable where the substructures are

sufficiently flexible such as high piers. In comparison with above two continuous girder types, statically indeterminate stresses such as temperature and drying shrinkage of concretes are additionally generated. However, the bridge will not fail even if a part of the structure is yielded, because the stress will be redistributed to the other piers.

## 6.8.2 Substructures

### (1) Determination of the Heights of the Piers

The heights of the column of piers were determined based on the vertical alignment of the road and evaluated scour depths. As previously mentioned, a determinant factor of the road profile was the design high water level.

As for the elevations of the footings, in general, they would be determined in consideration of the scour depth. For Ky Lam Bridge, a local scour reaching -12.54m in elevation is observed at right bank side approximately 70m downstream from the centerline. However, it will be costly if all the footings are embedded deeper than -13m. In this study, taking constructability and a cost into consideration, the elevations of the top of the footings were determined based on the following principles:

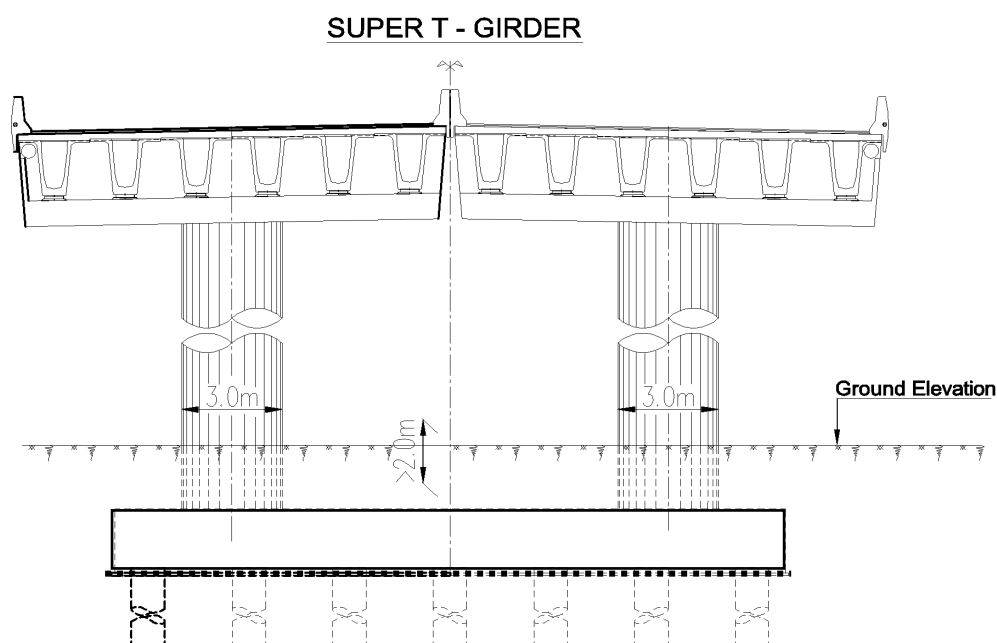
- The embedment of footings will be more than 2.0m from the lowest point of the existing ground level within the footing area.
- A pier height will be rounded up by 0.5m.

### (2) Piers

In accordance with the section “6.8.1 Alternative Study of Support Conditions for the Selected Bridge Plan”, piers can be categorized into three types due to different support conditions. As previously explained, since the support condition will be examined in detail considering the geotechnical investigations to be conducted, the detail shape of the piers cannot be determined in this stage.

The piers have circular section columns as discussed in the sections “6.2.3 Pier Type and Locations” and “6.6.1 Secular Variation of the River Channel”.

General views of the piers are shown in Figure 6.10. The dimensions of the piers will be re-examined in the D/D stage after the determination of the support conditions as mentioned above.



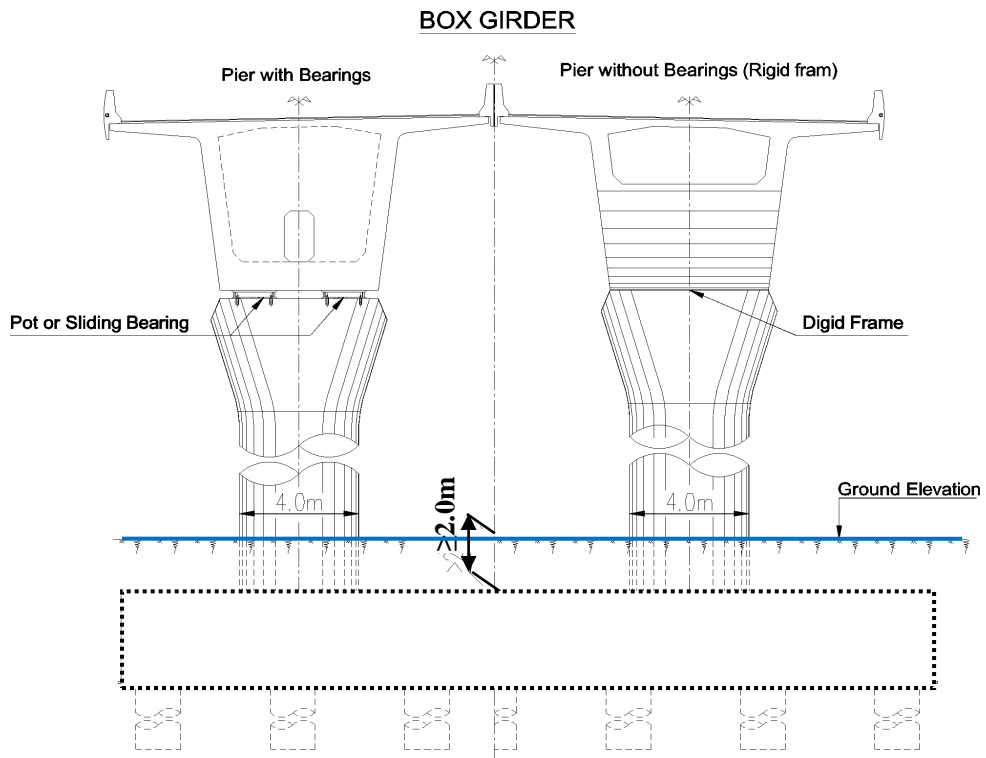
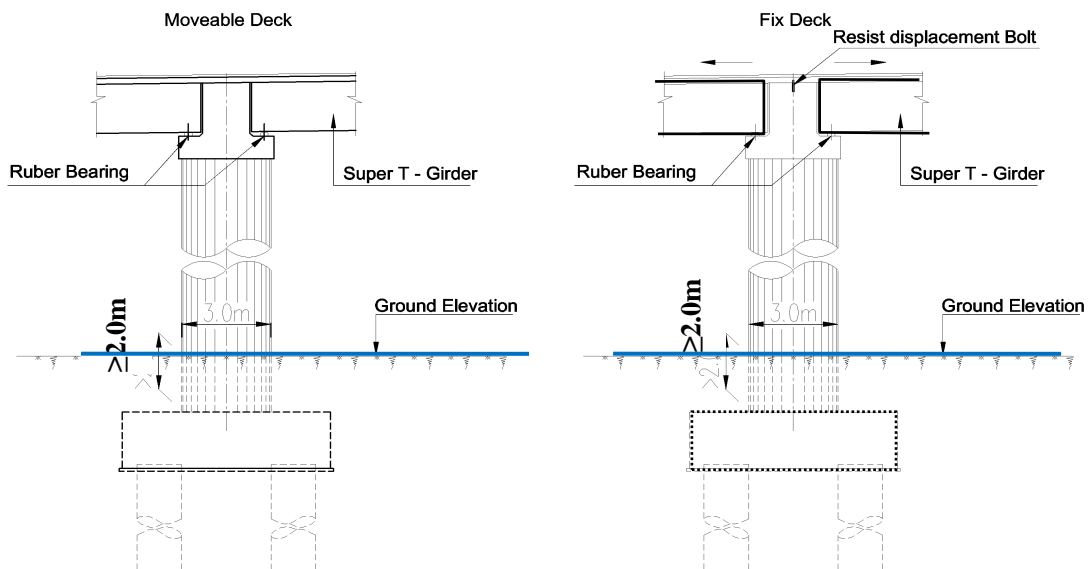
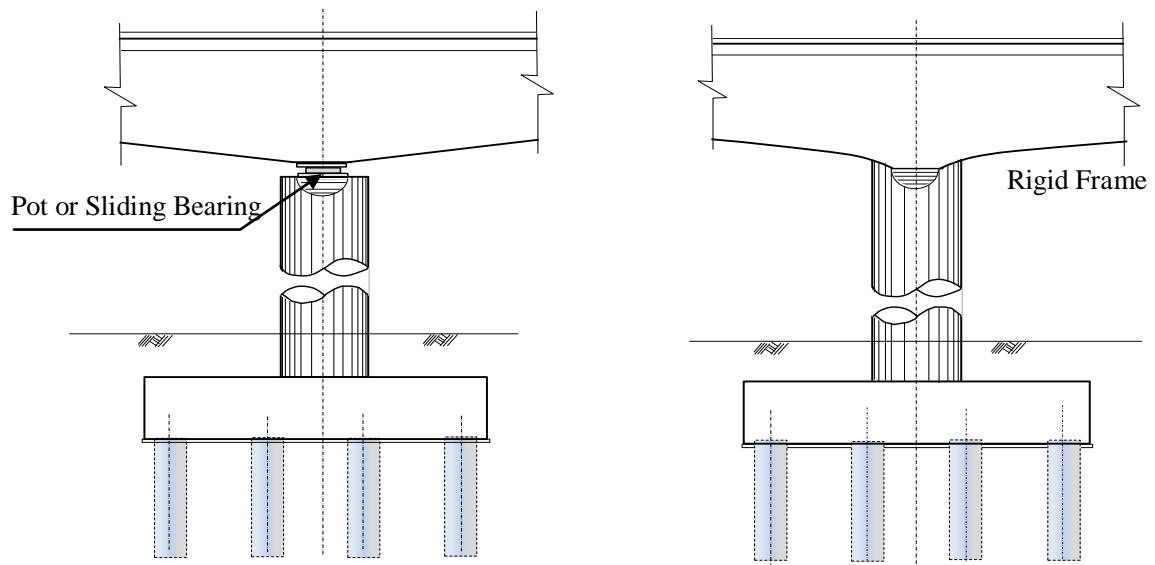


Figure 6.10 (1) Cross Section of the Piers

### SUPER T GIRDER



**BOX GIRDER**



**Figure 6.10 (2) Side View of the Piers**

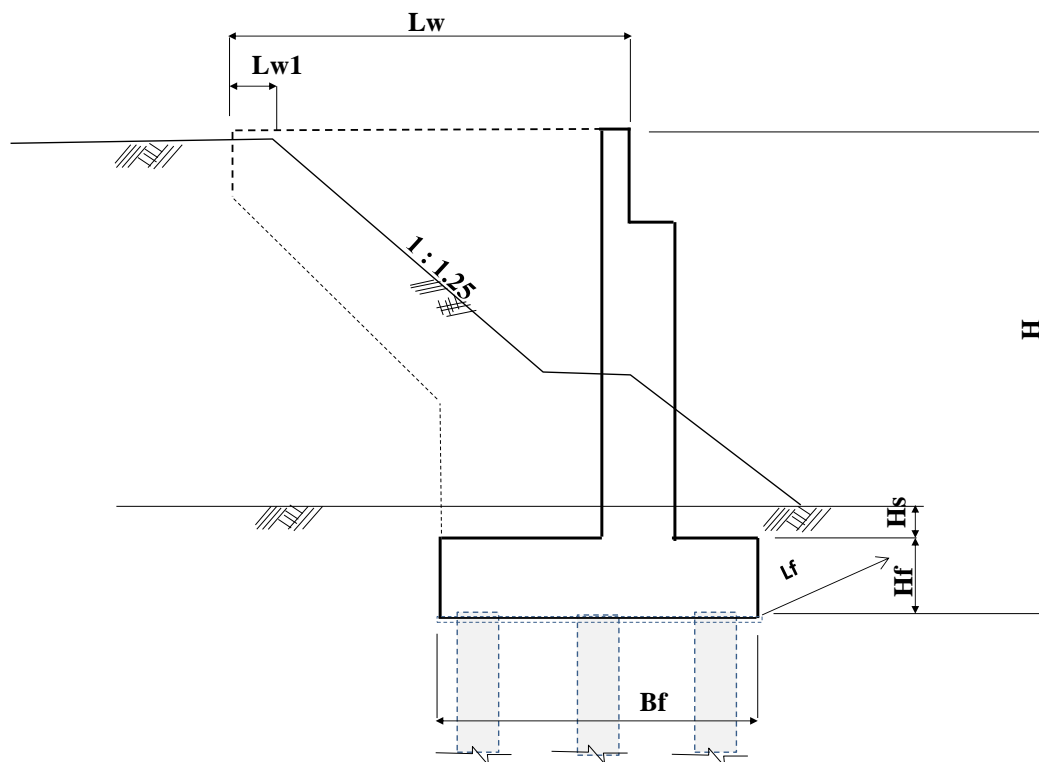
**(3) Abutments**

An inverted T-shape type abutment with 14m in height was applied for Ky Lam Bridge. This type of abutment is advantageous if its height is less than 15m due to constructability and economic aspects.

Dimension of the abutments are shown in Table 6.11 and Figure 6.11.

**Table 6.11 Dimensions of the Abutments**

Symbol	Dimension(m)		Remark
	A1 abutment	A2 abutment	
Hs	$\geq 0.5$	$\geq 0.5$	For aesthetic purposes and protection of foundation
H	10.0	14.0	
Bf	7.0	11.5	
Lf	26.0	26.0	
Hf	2.0	2.0	for Rigid body
Lw	10.0	10.0	$Lw \leq 10.0m$
Lw1	$>0.75$	$>0.75$	$Lw1 \leq 0.75m$



**Figure 6.11 Side View of the Abutments**

**(4) Foundations**

**(a) Selection of the Type of Foundation**

Type of the foundation is basically selected from three types which are typical in Vietnam; driven concrete piles, bored concrete piles and spread footings, depending on the depth of the firm bearing layer ( $N > 50$ ).

For Ky Lam Bridge, the geotechnical surveys for all the substructures will be carried out in the D/D stage. According to the borehole log in the previous studies, cast in place bored piles can be applied because a firm bearing layer was observed at about -50m from the ground level.

**(b) Arrangement of the Piles**

The following principles are applied to all the foundations of the bridges.

- The minimum distance between the centers of adjacent piles is  $2.5 \times D$ .
- The minimum distance from the end of pile cap concrete to the center of the nearest pile is  $1.0 \times D$ .
- The minimum embedment length to the bearing layer is  $1.0 \times D$ .

The preliminary arrangements of the piles are summarized in Table 6.12.

**Table 6.12 Pile Foundations**

	Piles				
	D (m)	Length (m)	Nos. Long.	Nos. Trans.	Total
Piers for Super T Girder	1.0	52-56	3	9	27
Piers with bearings for Box Girder	1.5	46-55	4	6	24
Piers of Rigid Frame for Box Girder				7	28
Abutments	1.0	57	3	6	18

**(c) Scour Depth Considered in the Foundation Design**

Depths of general and local scours are considered in foundation design. In the detail design, the scour depth will be evaluated for the design of the foundation based on the geotechnical investigations and river erosion analysis. It is noted that at least 13m of the general scour shall be considered

**6.8.3 Superstructures**

**(1) General**

The PC box girder for Ky Lam Bridge is laterally separated into two girders which are 12.99m in width and a gap between two girders is 0.2m, consequently, the width of the superstructure is 26.0m.

Span arrangement and superstructure type and construction methods are shown in Table 6.13.

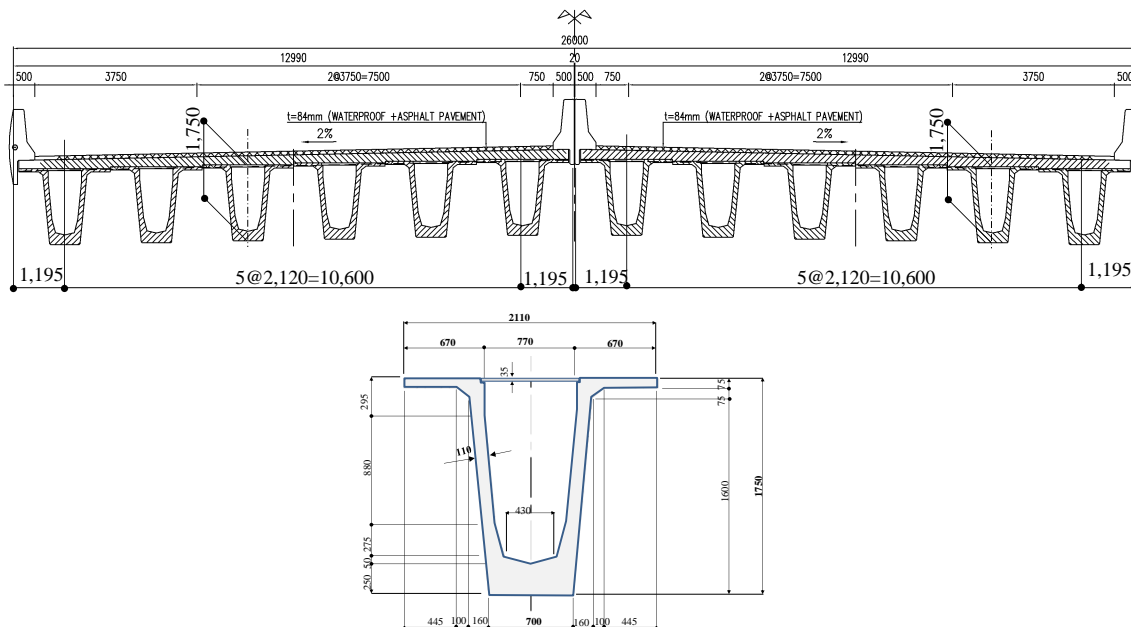
**Table 6.13 Bridge Type and Superstructure type and Construction method**

Location	Span arrangement (m)	Superstructure type	Construction method
A1 to P5	39.25+4@40.0	5-spans continuous super T girder	Precast girder election
P5 to P10	4@40.0+3925	5-spans continuous super T girder	Precast girder election
P10 to A2	65.0+5@100.0+65.0	7-spans continuous PC box girder	Free Cantilever Method

**(2) Structural Property**

**(a) Super T Girder**

Arrangement of Girders and Cross Section of Girder are shown in Fig 6.12. Each girder will be placed on the bearing vertically and 2% super elevation will be kept by changing the thickness of the deck slab



**Figure 6.12 Girder Arrangement and Dimensions of the Section of Super T Girder**

**(b) PC Box Girder**

The section of the girder is 1-Cell Box which is commonly applied for the width less than 18m. A girder height is 6.0m at pier and 2.5m at span center, which are approx. 1/17 and 1/40 of the span length, respectively. Detail dimensions of the girder sections are shown in Table 6.13 and Figure 6.13.

**Table 6.14 Dimensions of the Section of PC Box Girder**

	Member	Thickness(mm)	Reason for decision
At Interior Support	Upper Flange	Hfu 250	Connection between arrangement of longitudinal strands, anchors and transverse strand.
	Cantilever	Hh1 550	Strength for cantilever slab or arrangement of longitudinal strands and anchors.
	Slab	Hh2 250	Anchor of transverse strand.
	Lower Flange	Hfl 1000	Compressive stress or efficiency of section.
	Web	Bw 600	Shear strength as web or strength as box section.
At Center of Span	Upper Flange	Hfu 250	Bending strength as deck.
	Cantilever	Hh1 550	Same as interior support
	Slab	Hh2 250	Same as interior support
	Lower Flange	Hfl 250	Connection of longitudinal strands or strength as box section

	Web	Bw	400	Connection of longitudinal strands or strength as box section
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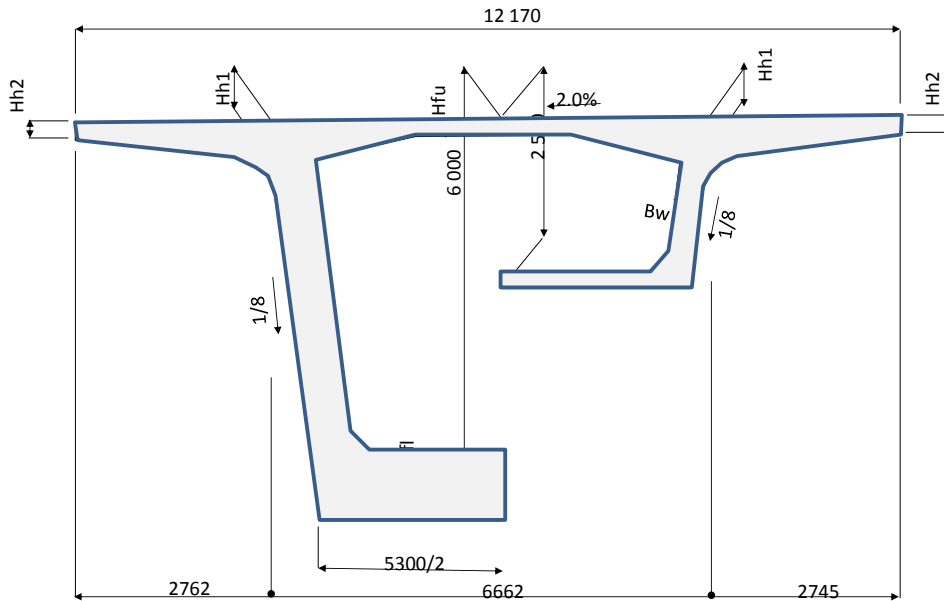


Figure 6.13 Dimensions of the Section of PC Box Girder

### (3) Transversal Prestressing

Transversal prestressings are recommended for durability of the deck slab considering the importance.

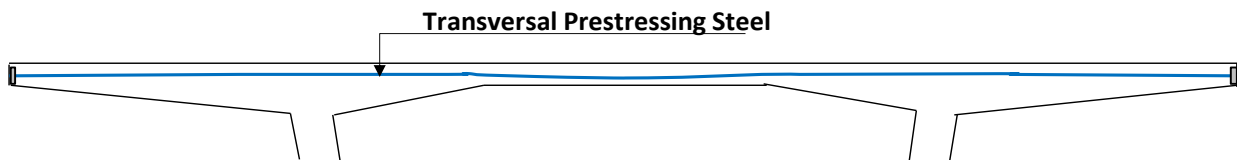


Figure 6.14 Transversal Prestressing of the Deck Slab of the PC Box Girder

## 6.8.4 Equipments

### (1) Bearings

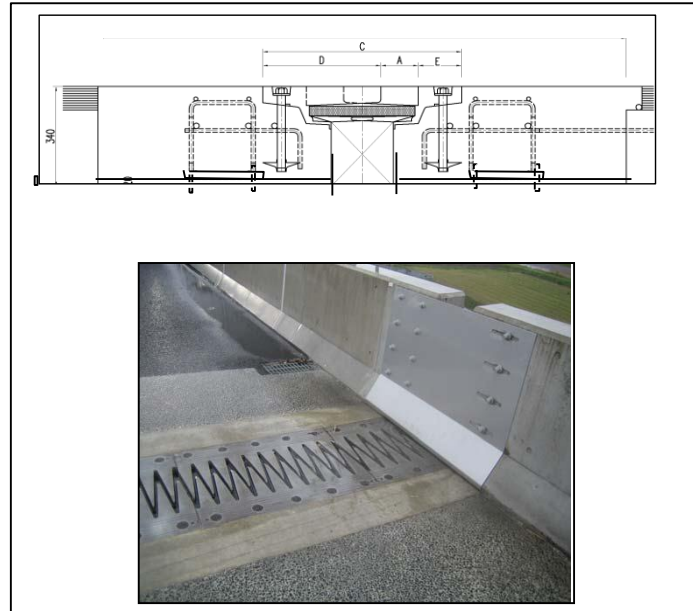
As explained in the section 6.8.1, the support condition as well as bearings will be examined in the D/D stage.

### (2) Expansion Joints

Expansion joints will be installed at abutments A1, P5, P10 and A2. Modular type joints which can accommodate large movement and is advantageous to durability, water proof, and driving comfort, will be applied for P10 and A2. Finger Type Expansion Joint will be applied for A2 and P5. Design displacements of the expansion joints are preliminary calculated as shown in Table 6.14. Figure 6.14 shows these type of Expansion Joint

### Finger Type Expansion Joint on the A1 Abutment and P5 Pier

Finger Type Expansion Joint on the A1 Abutment and P5 Pier



### Modular type Expansion on the A2 Abutment and P10 Pier

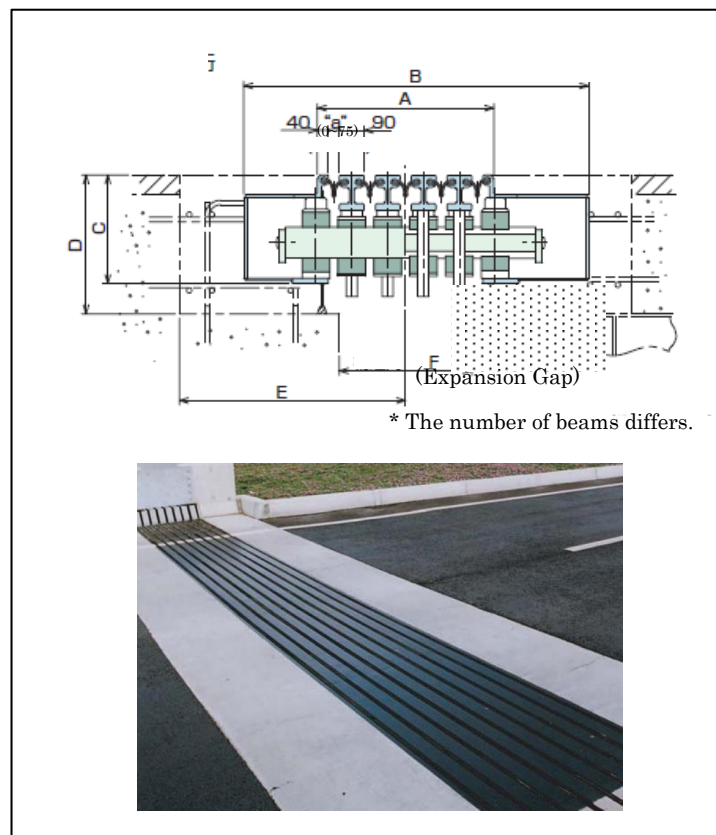


Figure 6.15 Finger Type and Modular Type Expansion Joint

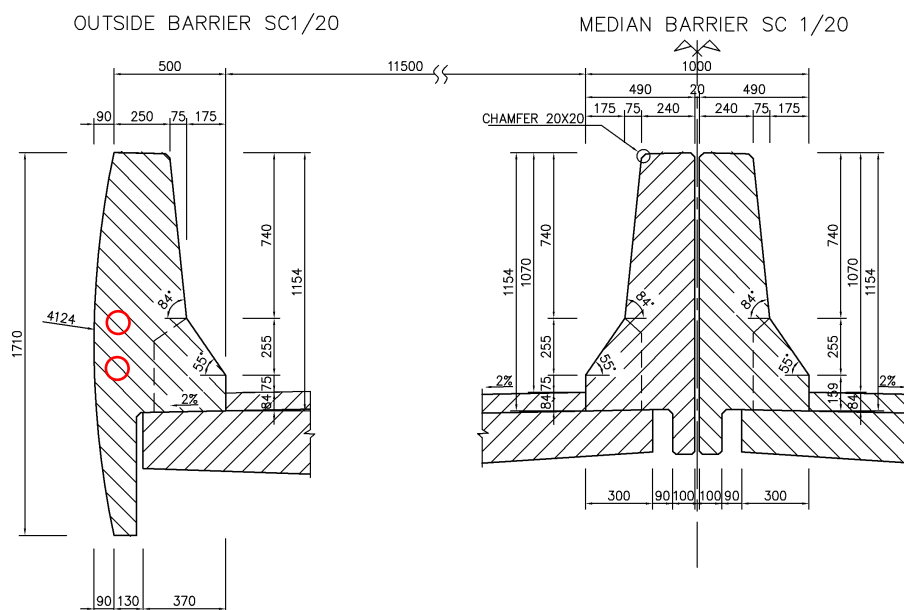
**Table 6.15 Displacement for Expansion Joint**

Item	Abutment A1		At Pier P5		At Pier P10		Abutment A2	
	Creep and Shrinkage	Temperature	Creep and Shrinkage	Temperature	Creep and Shrinkage	Temperature	Creep and Shrinkage	Temperature
Displacement (mm)	54	47	91	79	149	138	156	146
Load Factor at Service I	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Modified Displacement (mm)	65	57	110	95	179	166	188	176
Design Displacement (mm)	122		205		345		364	
Type Expansion Joint	Finger Type		Finger Type		Modular Type		Modular Type	

**(3) Guard Wall**

General concrete parapets are placed on outside of the each superstructure. Two sheaths for electric and telecommunication cables are embedded in the parapets. Dimensions of the guard wall are shown in Figure 6.15.

GENERAL DIMENSION OF BARRIER ON BRIDGE

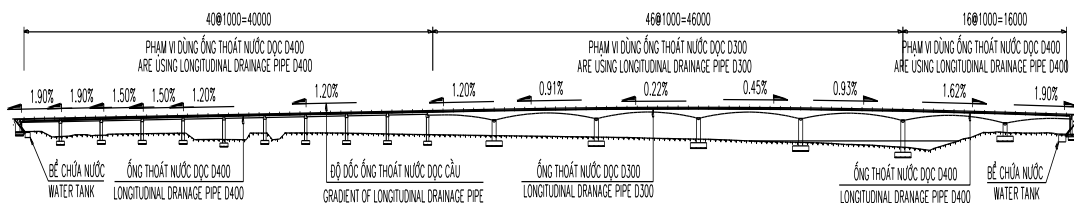


**Figure 6.16 Detail of Railings made of Concrete**

**(4) Drainages**

The Project is located in a high rainy region. Therefore, the drainage of the bridge surface shall be carefully examined; otherwise, stagnant rain water on the bridge surface may block the traffic. And as mentioned in 6.6.8 Environmental Considerations, The bridge floor runoff shall be collected and deal with, so that they will not enter into water body directly. The number of drainage and filtration equipment for clarifying will be examined in the D/D stage. The Concept of Drainage system is shown in the Figure 6.16

### BỐ TRÍ CHUNG THOÁT NƯỚC/ GENERAL VIEW OF DRAINAGE



#### TẠI NHỊP SUPPER "T"/ AT SUPPER "T" SPAN

#### TẠI DẦM HỘP/ AT BOX GIRDER

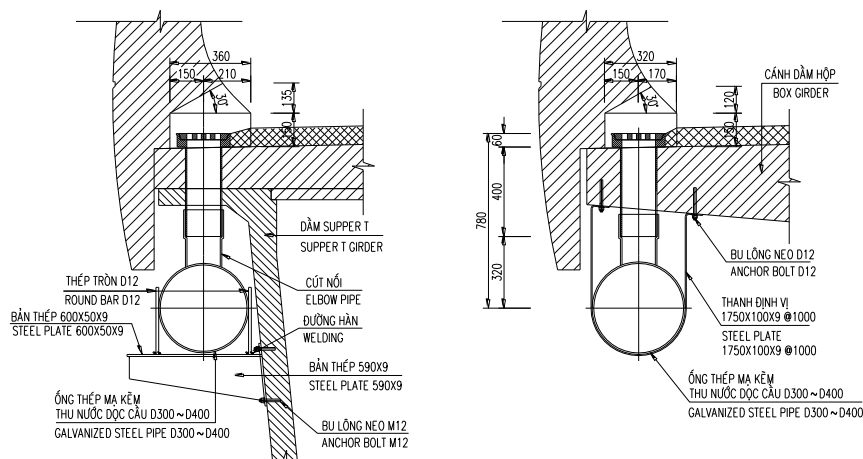


Figure 6.17 Concept of Drainage system

### 6.8.5 River Bank and Scouring Protection Works

Because of the secular variation of the river channel, river bank protection works are indispensable to maintain the river channel between the abutments. Detail examination of the bank protections will be conducted in the D/D stage.

Existing river bank protections on both sides of the river are guiding the flow into the railway bridge. These protections will be evaluated and utilized as much as possible.

## 7 Basic Design of Road Embankment

### 7.1 Typical Cross Section

The PKG3A section is passing through the holm of Thu Bon River with Ky Lam Bridge and embankment sections. Planned height of the neighboring embankment section of Ky Lam Bridge section is rather higher than other embankment sections and high embankment type typical cross section is needed to apply.

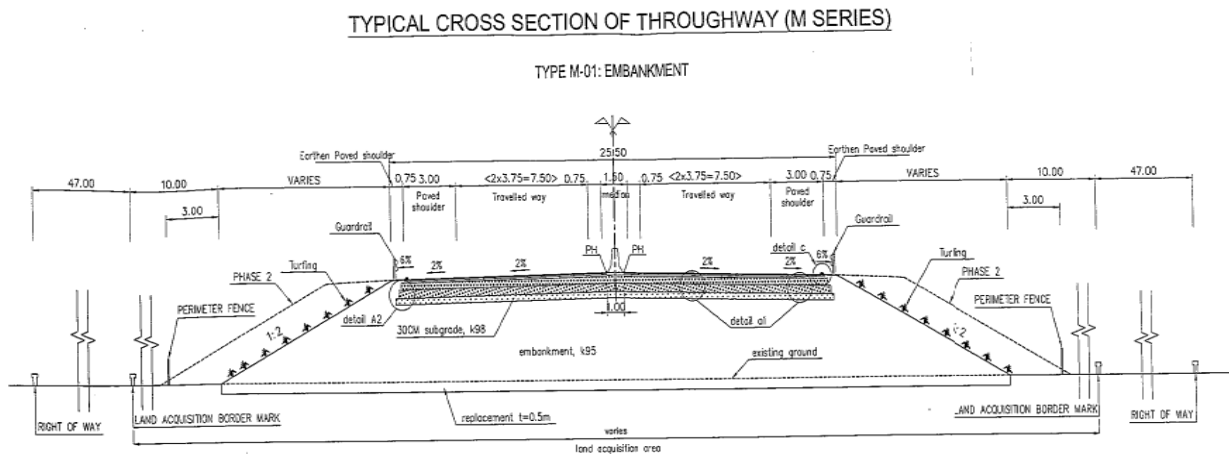


Figure 7.1 Typical Cross Section of Embankment Section ( $H \geq 10m$ )

### 7.2 Frontage Road Plan

Two existing roads are crossing the DQE at KM16+880 and KM18+070 on the PKG3A. Detour with the frontage road is planned in substitution for the existing crossing road at KM18+070. Typical cross section of the frontage road is proposed in accordance with the Standard for design of rural roads 22TCN 210-1992 as shown in Figure 7.2.

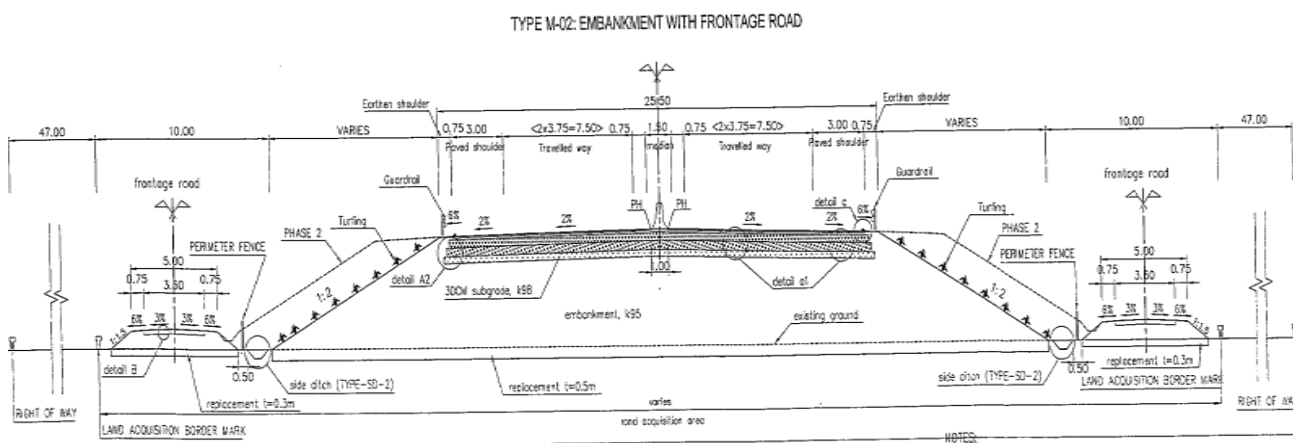


Figure 7.2 Typical Cross Section of Embankment Section with Frontage Road

### 7.3 Soft Soil Treatment

According to the F/S, there is no soft soil section in the PKG3A section. However, the PKG3A section is passing through the holm of Thu Bon River and careful investigation on geotechnical condition by geological survey is essential in the detailed design stage.

## **8 Natural Environmental Considerations**

### **8.1 Environmental Impacts during Construction Period**

#### **8.1.1 Air Quality**

- Dust pollution from Transportation of bulk materials: Lime, gravel, sand and other bulk materials are very likely to cause dust pollution during their transportation whose impact coverage can reach 150m leeward direction (on 150m leeward direction, TSP pollution may still exceed the air quality standard by 4 times), so vehicles transporting bulk materials must be managed strictly. Prevention measures such as sprinkling water and covering cloth can be taken.
- Dust pollution from Access Roads: If access roads are paved or graveled, then flying dust is going to be relatively light. If the builder's access roads are only earth road surfaces, the dust pollution caused by vehicle transport will be more serious, and the spreading area will be relatively large. According to relevant data, wind-borne flying dust is derived from falling dust with small particle diameter, in unpaved road surface (earth), dust with particle diameter smaller than  $5\mu\text{m}$  accounts for 8%, dust with particle diameter 5-10 $\mu\text{m}$  accounts for 24%, dust with particle diameter greater than 30 $\mu\text{m}$  accounts for 68%, therefore, temporary roads, unpaved access roads and roads under construction are extremely likely to produce flying dust. But compared to dust pollution caused by mixing stations, hazard of wind-borne flying dust is relatively small with shorter impacting cycle. In order to reduce dust amount and to reduce its adverse effect effectively, it is proposed to sprinkle water frequently in populous residential areas. Sprinkling water can reduce dust effectively according to relevant data (reduces 70% of dust amount).

#### **8.1.2 Water Quality**

At the time of underwater works, such as piles, foundations, and temporary support, the water quality of Thu Bon River will be affected. In addition, the disturbance to the riverbed sediments may increase the suspended solid (SS) load in these localities. Based on the experience obtained from similar projects, the load of SS within 100m radius of the site is noticeable. Due to dispersion, the SS load will be reduced with distance from the site. When the work is completed, such impact will end immediately. The oil leaked from the operation of machinery of the bridge construction may be another major source of water pollution. In areas where loose materials such as cement and lime are stockpiled near the river, water pollution might be caused by strong rainfall which may bring the materials into the rivers. In addition, domestic wastewater will be generated from construction camps which may also cause water pollution unless it is properly controlled and treated at the site.

#### **8.1.3 Ecosystem and Fish Species**

The construction of bridges may lead to loss of aquatic animal habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. However, these impacts are short-term, reversible, and happen only during the construction phase. After the bridge construction, the populations of aquatic animal will be restored. The project can minimize these potential impacts by using crushed stone instead of sand mining from river beds to avoid affecting populations of aquatic animal.

#### **8.1.4 Resident and Sensitive Object**

Sensitive objects can be affected by construction activities of the project are the residents of Ky Long, Ky Lam villages and the residents on the access road to Ky Long and Ky Lam villages. Those objects will be affected to health by dust pollution, noise and dirty condition.

- Noise pollution: The major noise sources during the construction phase are construction equipments and transportation vehicles. Although the noise arising from these sources is temporary, it could affect the neighboring receptors unless there is a stringent control measure. In the course of the actual construction, many sets of machinery may work at the

same time in one place, then noise will be dispersed to the area than predicted value. Considering that the actual conditions are more complicated, it is difficult to include sound level superimposition for the estimations.

- Impacts on Health and Social Relation by concentration of population: Outside labourers associated with construction activities may disrupt the local social order within the project area, causing social tensions. When construction workers go into workers camp sites and construction areas, they live there during the construction period, interacting with the local population. There is the potential risk of having people conducting business with the workers, possibly including commercial sex workers, which the local communities consider as “social evils”, as most of the workers are likely to be men away from their families. An increase in the transmission of HIV/AIDS and other sexually transmitted diseases, particularly via prostitution, are risks commonly linked with major construction projects. These are more significant when the project involves large number temporary construction workers.

### **8.1.5 Traffic**

Project construction requires large and diverse construction equipment such as bulldozers, excavators, asphalt concrete finisher etc and especially large dump trucks transporting construction materials and disposal wastes. The risk of accidents is very high considering so many vehicles are passing through the residential areas. Inland waterway on the Thu Bon River will be affected by construction work on the river.

## **8.2 Mitigation measures during construction period**

### **8.2.1 Minimizing Impact by Wastes**

- The material stockpile site shall be far away from surface water bodies and areas prone to surface run-off. The materials will be bagged or covered. Open ditches shall be built around the stockpile site in order to intercept wastewater.
- Solid waste arising from pier construction shall be collected and conveyed to designated places for safe disposal on a timely manner. The solid waste will be used as raw materials for road construction wherever possible.
- The bridge works shall be scheduled to avoid high flow season.
- The provision of water spray vehicles shall be specified in the tender documents of construction to spray the unpaved ground, and store piles and other areas where airborne dust may originate. The water spray operation will be carried out in dry and windy days, at least twice a day (morning and afternoon). The frequency of water spray near sensitive receptors, such as villages, schools, and pagodas will be increased as needed. Trucks transporting loose materials, such as cement, sand and lime, shall be covered.

### **8.2.2 Minimizing Noise Impacts:**

Regarding residential areas near construction sites, noise monitoring shall be conducted. If the monitored value exceeds the standards, construction units must be obliged to take noise reduction measures. The construction materials will be transported through existing roads to the construction sites. The transportation will be carefully scheduled to minimize adverse impacts on residents and students as well as the existing traffic. The transportation vehicles will be required to slow down during passing townships and nearby schools and pagodas. The construction activity in residential areas will be scheduled in daytime only, and the noisy equipment will be prohibited from night operation. The construction site shall be fenced.

### **8.2.3 Minimizing Impacts on Community Health:**

The project will address the needs for better dissemination of information about HIV/AIDS and other risks such as drug abuse and human trafficking. Under the Project, HIV/AIDS and Human

Trafficking Prevention Programs shall be carried out to ensure that communities are not subject to increased risk of sexually transmitted infections, and drug and human trafficking because of the expressway and improved transportation. The HIV/AIDS program should contain awareness campaigns at the construction sites and in the communities, as well as developing peer educators and community monitoring combined with the prevention of human trafficking, awareness on safe migration, and community monitoring.

### **8.3 Environmental Impacts and Mitigation Measures during Operation Phase**

#### **8.3.1 Hydrological regime of Thu Bon River:**

The Thu Bon River, section ahead Ky Lam Bridge is a river section with many bend, that reduce the drainage capacity of Main River. The Ky Lam Bridge construction will increase drainage capacity limit factor of river. The project can minimize these potential impacts by providing a bridge with an opening double time of the existing railway bridge.

#### **8.3.2 Population and Community Health**

- Dust pollution: Washing pavement in operation phase. Washing works include collecting fall material, cleaning sand soil.
- Community separation: Ky Lam bridge approach road cutting the Ky Long and Ky Lam villages may impact residential area division. This impact is small because frontage road and underpass to ensure the link between residential areas will be installed.

## 9 Social Environment and Resettlement

### 9.1 Scope of land acquisition and resettlement

The impacts on land acquisition and resettlement are being updated with detailed measurement survey (DMS) in parallel to the progress of setting out landmarks. Landmarks are currently still missing in some sections of Dien Ban district so the scope of land acquisition and resettlement in this report is based on the feasibility studies and the cadastral maps of the affected communes. Updated social environment and resettlement issues of the PKG3A (Ky Lam Bridge) will be included in details in the RAP of Dien Ban district.

According to the RAP of Quang Nam province, there are a total of 569 households (2,459 persons) in 3 communes of Dien Ban district affected by the project's land acquisition, including Dien Tien commune, Dien Tho commune, and Dien Quang commune. Of which:

- 154 households will lose their residential land either partially or fully with the total affected area of 74,182 m<sup>2</sup>.
- 440 households will lose their agricultural land with the total area of 612,145 m<sup>2</sup>.
- 154,602 m<sup>2</sup> of other land (public land) will be impacted.
- 55 households will fully lose their houses with the total area of 3,300 m<sup>2</sup>, while the other 78 households will partially lose houses with the total area of 2,715 m<sup>2</sup>.
- 64 households will be relocated due to loss of residential land (both with and without structure), while the other 102 households are due to loss of agriculture land.
- 520,323 m<sup>2</sup> of land under rice crop, 79,579 m<sup>2</sup> of land under maize crop, 13,944 m<sup>2</sup> of land under sugar cane, 88,123 eucalyptuses and 1,995 other trees will be affected.

Other affected structures, including kitchens (which are separated from living houses), houses for poultry, other structures with fibro cement font cover, cement playground, brick wall fence, iron gate, graves, wells are shown in the table below:

Kitchen (m <sup>2</sup> )	Houses for poultry (m <sup>2</sup> )	Other structures with fibro cement font cover (m <sup>2</sup> )	Cement playground (m <sup>2</sup> )	Brick wall fence (m <sup>2</sup> )	Iron gate (m <sup>2</sup> )	Number of Graves	Number of Wells
4.445	829	1.567	1.217	730	243	648	103

### 9.2 Mitigation measures to social and resettlement impacts

Policies of compensation, allowance and resettlement of the project are following the World Bank Policy on Involuntary Resettlement (OP 4.12- December 2001) and the laws and regulation of the Government of Viet Nam (GOV). Major mitigation measures are applied for each kind of impact as follows:

#### ➤ Loss of house and land:

Affected people will be compensated for their loss of house and land at replacement cost with additional assistances so that they will be able to maintain their living standards at least as well as present.

In order to ensure all compensations are paid at replacement cost, the project contracted with licensed independent land price appraisers to carry out Replacement Cost Survey (RCS) for all affected assets based on the prevalent market prices. Findings of the RCS will be submitted to the PPC for comparison, revisions and final decision making.

For relocating households, resettlement sites will be well developed with physical infrastructures and social services such as internal roads, water and power supply system, drainage and sewage water treatment systems, and etc. There are 4 resettlement sites planned in Dien Ban district, including 1 site in

Dien Tien commune, and 3 sites in Dien Tho commune.

➤ **Loss of livelihood and source of incomes**

Livelihood restoration programs are developed for displaced people who lose their productive land and vulnerable groups to ensure they can maintain or improve their livelihood and income at least as well as before the project. The programs are based on consultation with APs and other stakeholders, especially local NGOs.

The implementation of livelihood restoration programs, including outcome of the training, extension services, and etc. will be closely monitored by the project authorities and the external monitoring agency. A post-implementation evaluation by the external monitoring agency would be carried out to determine whether the objectives of the income rehabilitation and livelihood restoration have been achieved. The project authorities will provide additional resources for continuous assistance to the APs until they restore their livelihoods and incomes.

➤ **Vulnerable people**

Vulnerable groups are defined in the project as: 1) Certificated poor households, 2) Female headed households with dependents, 3) Households with disabled or severe disease persons, 4) Children and elderly households who are with no other means of support, 5) Landless household; 6) Ethnic minority, and 7) Socially policed household. Depending on particular cases, they will get additional assistances in term of cash, livelihood or land.

**9.3 Framework and Schedule of Land Acquisition and Resettlement**

Updated resettlement plan (URP) for Dien Ban district, Quang Nam province (including the priority package -3A) is planned to complete in the end of May 2012. This will give sufficient time to implement site clearance for commencing the construction work of the package 3A in September 2012. Main activities and schedule of land acquisition and resettlement for Dien Ban district are shown in table below:

No.	Activities	Proposed timing	
		Start	Finish
1	- Review of existing reports and policies - Setting up detailed work plan	1/12/2011	30/12/2011
2	Collecting secondary data and updated social-economic situation of PAPs in 3 affected communes of Dien Ban district_	06/12/2011	15/1/2012
2.1	Meeting with relevant stakeholders: DARD, DONRE, Provincial Departments, NGOs, PRC		
2.2	Meeting with local authorities		
2.3	Meeting with MASS Organization		
3	Detailed measurement surveys (DMS)	05/2/2012	30/3/2012
4	Replacement cost survey	15/12/2011	05/2/2012
5	Supplementary social survey		
5.1	Studying on updated situation of project sites	06/12/2011	30/12/2011
5.2	Additional social survey for 126 potentially affected households in Dien Quang commune and vulnerable groups	06/12/2011	30/12/2011
6	Resettlement site survey	01/3/2012	30/3/2012
7	Survey for income restoration program (IRP)	06/12/2011	06/2/2012
8	Community meetings		
8.1	Consultation meetings for SIA and EIA	02/1/2012	14/1/2012

No.	Activities	Proposed timing	
		Start	Finish
8.2	Consultation meetings for IRP	01/3/2012	15/3/2012
8.3	Consultation meeting for Resettlement sites	15/4/2012	30/4/2012
9	Prepare draft URP – Dien Ban district	01/5/2012	30/5/2012
9.1	Consultation meeting for draft URP	15/5/2012	
9.2	Disclosing the URP	20/5/2012	
10	Finalizing the URP	30/5/2012	
11	Approval and implementation of the URP	15/6/2012	30/12/2012

## 10 Construction Planning

### 10.1 Work Content

The Works contain following major items.

- Temporary Works: Entrance access road, Site access road, Temporary bridge
- Bridge Works: Superstructure (Super T girder 10@40m+PC Box girder 65m+5@100m+65m=1,030m)
- Road Works: W=26m, L=170m

### 10.2 Major Work Quantity

Major work quantity is shown below table.

**Table 10-1 Major Work Quantity**

	Description	Unit	Quantity
I	Bridge		
I-1	Substructure	each	12
	Bored Pile D=1.5m	m	13,376
	Bored Pile D=1.0m	m	3,064
	Concrete 30Mpa	m <sup>3</sup>	18,332
	Concrete 10Mpa	m <sup>3</sup>	480
	Reinforcement Bars	t	2,750
I-2	Superstructure	m	1,030
	Concrete 45Mpa	m <sup>3</sup>	11,615
	Concrete 25Mpa	m <sup>3</sup>	212
	Reinforcement Bars	t	1,763
	PC Tendon 19S15.2	t	512
	PC Tendon 4T15.2	t	74
	Asphalt Concrete Surface Course t=80mm	m <sup>2</sup>	4,126
II	Road		
	Embankment (K=98%, K=95%, Slope)	m <sup>3</sup>	82,000
	Slope Protection	m <sup>2</sup>	2,460
	Sub-base Course t=40cm	m <sup>3</sup>	963
	Base Course t=40cm	m <sup>3</sup>	903
	Anti skid AC surface 3cm	m <sup>2</sup>	4,244
	AC fine course 5cm	m <sup>2</sup>	4,266
	AC binder course 8cm	m <sup>2</sup>	4,304

### 10.3 Temporary Works

#### (1) Temporary Roads

The temporary road is divided into two categories

- 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 10-2 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

- Category 2: Site access road

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

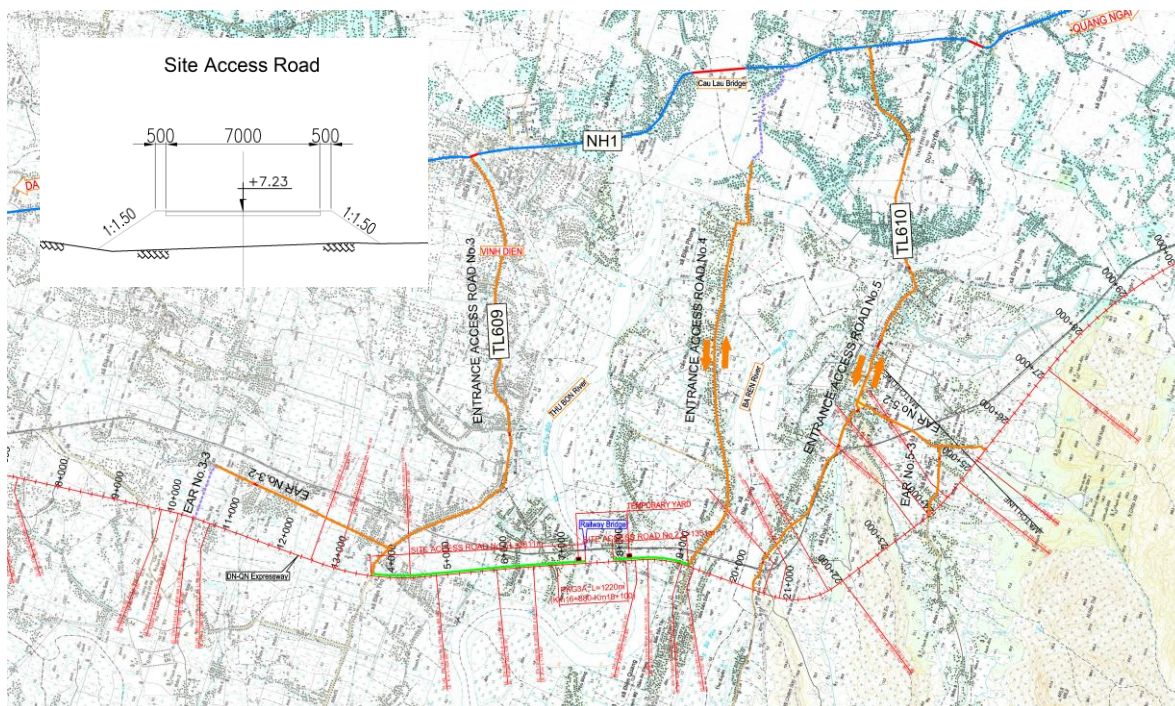


Figure 10-1 Temporary Roads

**(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 46 m in width.

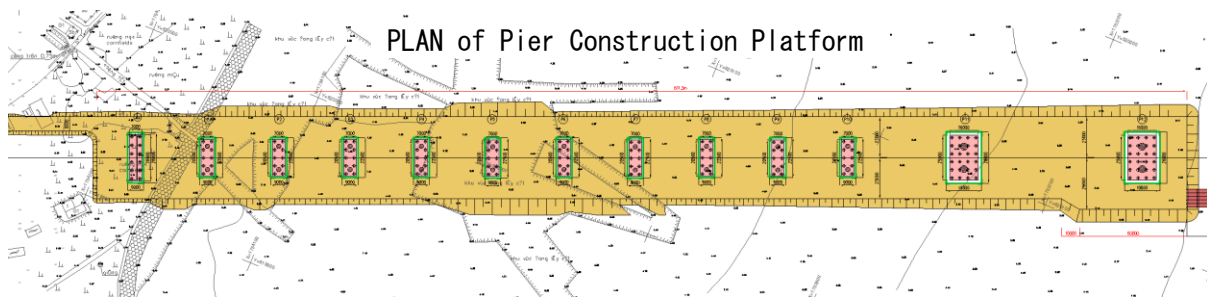


Figure 10-2 Pier Construction Platform

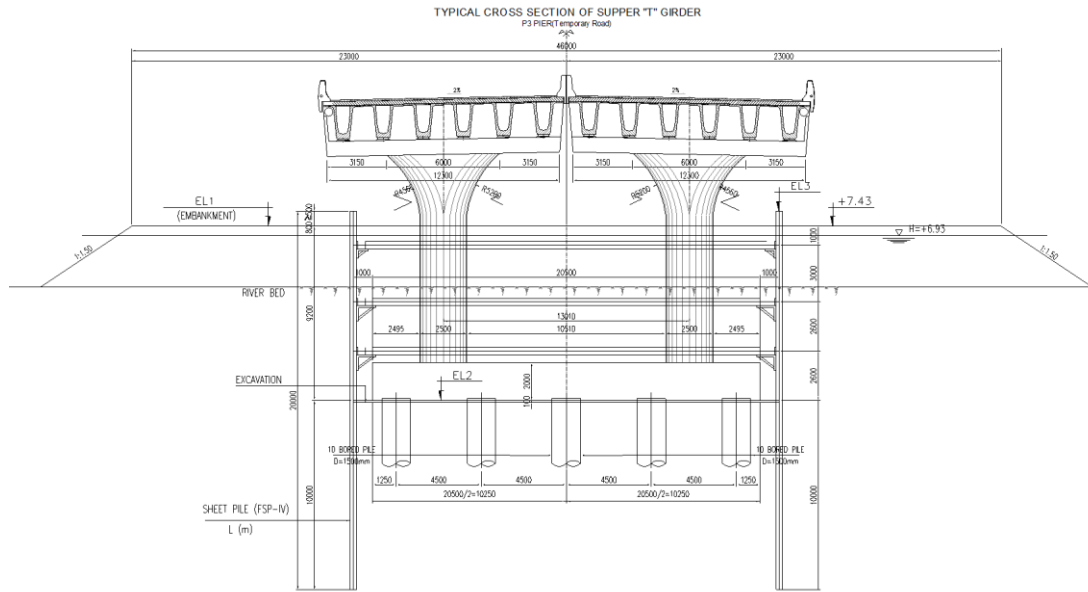
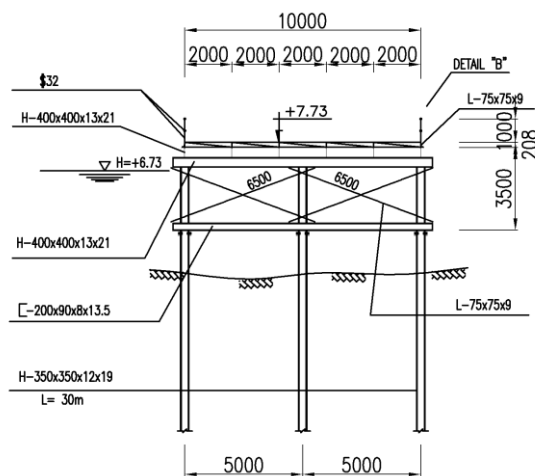
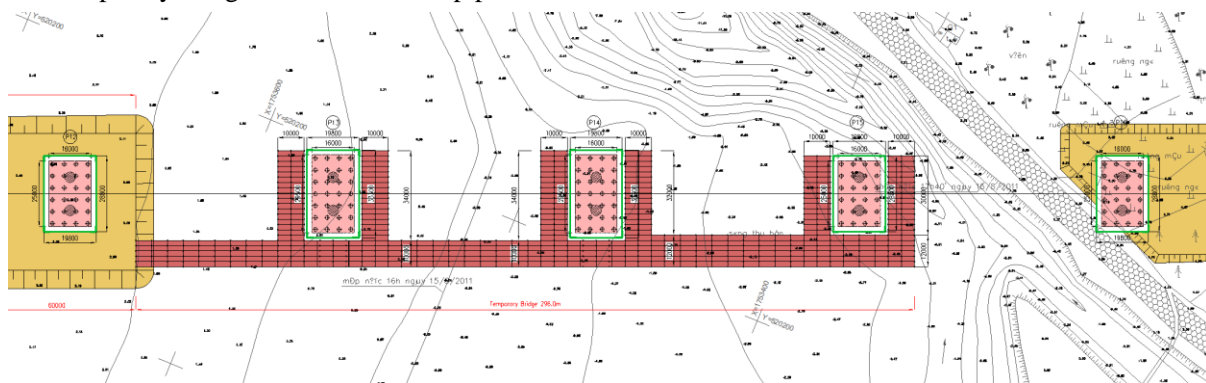


Figure 10-3 Pier Construction Platform Cross Section

### (3) Temporary Bridge

The temporary bridge is installed in deep position of river at P13, P14 and P15.



Temporary bridge length = 295m  
 Temporary bridge width = 10m, 12m  
 Install area = 5120m<sup>2</sup>

Figure 10-4 Temporary Bridge

## 10.4 Construction Method of Ky Lam Bridge

### 10.4.1 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 wall construction. There is considerable local experience in Vietnam of this form of temporary works construction.

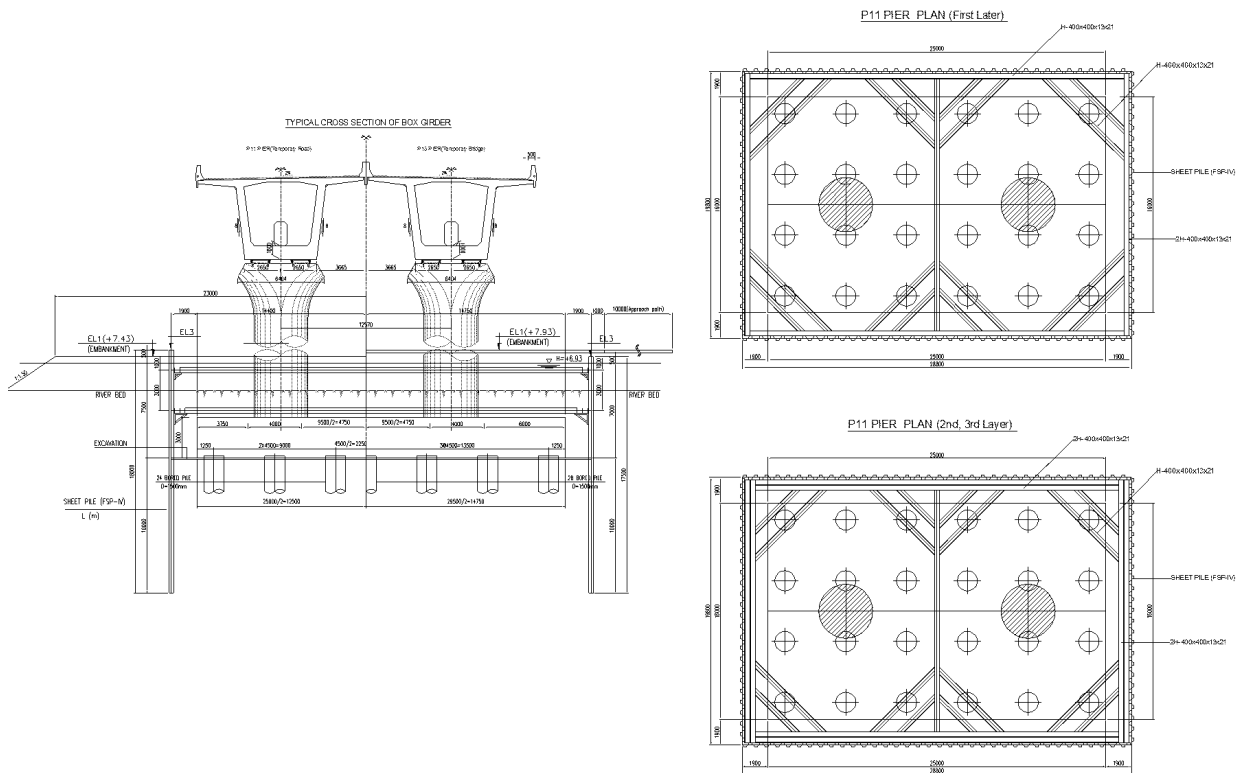


Figure 10-5 Cofferdams for Pier Construction

#### (2) Pile Construction

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

##### ● Earth Drilling Method

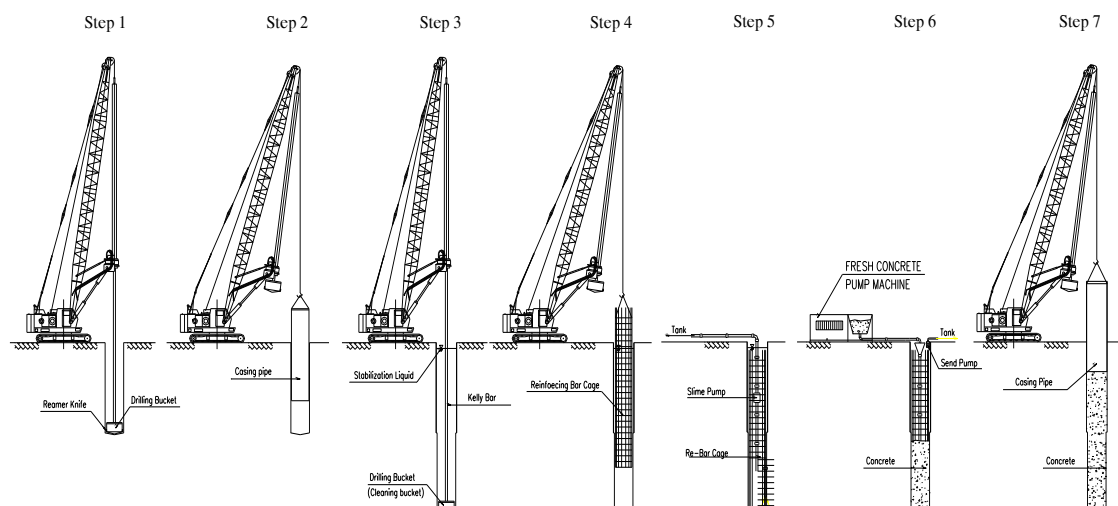
Using the so-called earth drilling method, the boring shall be made by rotating the drilling bucket while displacing the excavated material to the ground.

One of the most important feature of the method is the use of soil-stabilizing agent such as bentonite to prevent the wall of the bored-hole from collapsing, if the work is undertaken with the ground water possibly intruding into the bore-hole, that is, if the excavation is made below the water table.

The potential problem with the use of the earth-drilling method at this specific site include:

- The disposal of the waste materials which include the stabilizing agent could create environmental problems unless properly disposed.
- The excavation bucket tends to damage the wall of the bored hole.

The typical work sequence of the Earth Drilling method is shown below.



**Figure 10-6 Construction Step of Earth Drilling Method**

● Quality Control of Earth Drilling Method

Piles shall be appropriately tested both during construction and after completion in accordance with the following requirements :

Bore Hole

**Table 10-3 Bore Hole Testing Requirements**

Element	Condition	Tests and/or Measurement	Number of Tests
Alignment	Location Horizontal Angle Vertical Angle Hole Diameter Bore Hole depth	Survey Sonic and Drilling - Monitor Test Measurement	Each pile Each pile Each pile Each pile
Embedment Length to Bearing Stratum	Soil Condition	Check Boring Sampling	By the Engineer Each pile
Stability of Bore Hole	Water Level in Hole Slurry Condition	Hydrometer Viscosity Test	4-5 times/ pile 4-5 times/ pile

Pile Concrete & Reinforcement

**Table 10-4 Pile Concrete and Reinforcement**

End Pile	Slurry Sedimentation	Measurement Slurry Test	Number of Test
Reinforcement Cage	Shape	Bar Arrangement Test	Each pile
Pile Concrete	Ready Mixed Concrete	Slump Test Air Content Test Compressive Strength Test	Each pile Each pile Each pile
Completed Pile	Pile Length & Shape  Strength	Integrity Test (Sonic Coring Test) Core Sampling Test	One-two Place/Pier Each pile
	Loading	Load Test	Each location by the Engineer

### 10.4.2 Superstructure (1) Crane Erection(SUPPER "T" GIRDER)

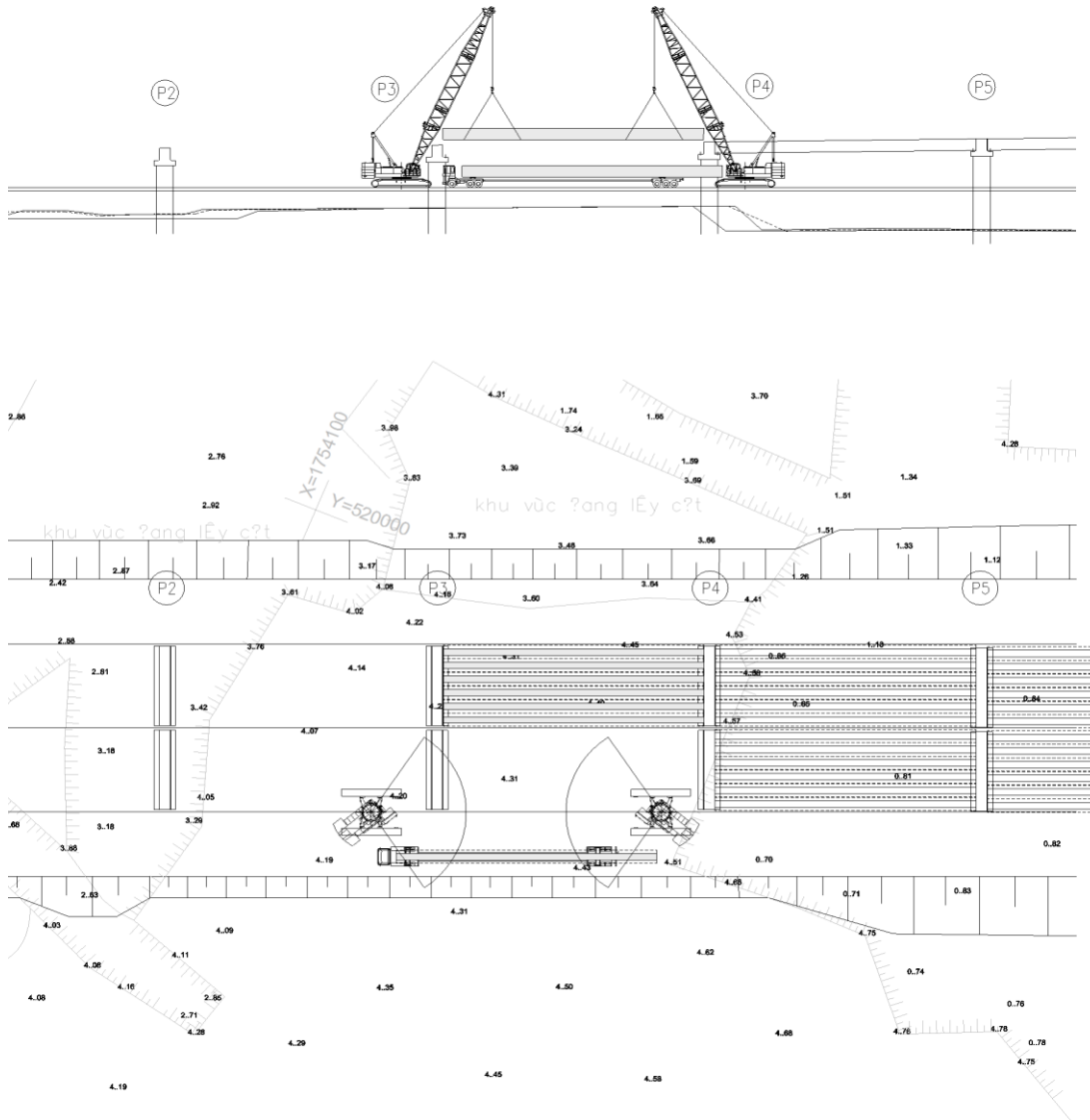


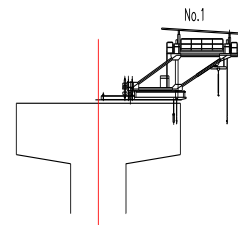
Figure 10-7 Crane Erection(SUPPER "T" GIRDER)

## (2) Cantilever Construction

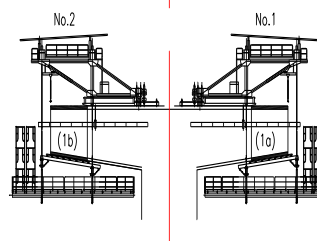
The cantilevering is undertaken in-situ by means of carriage Travelling Forms supporting the formwork and proceeding symmetrically/ each side of the support pier by a mobile frame moving within the deck.

Construction steps

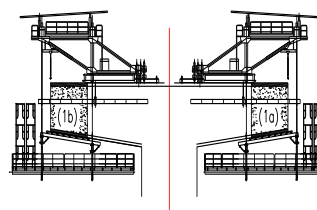
1. Travelling form assembled



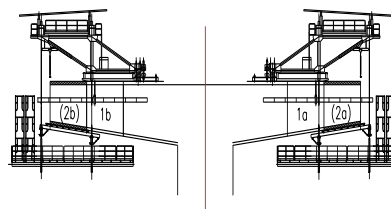
2. Travelling Form assembled and the First set of Blocks started.



3. Production of the first set of Blocks.



4. Transfer of Travelling Forms to work on the second set of Blocks.



**Figure 10-8 Cantilever Construction Steps**

## (3) Construction of Column Head

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.

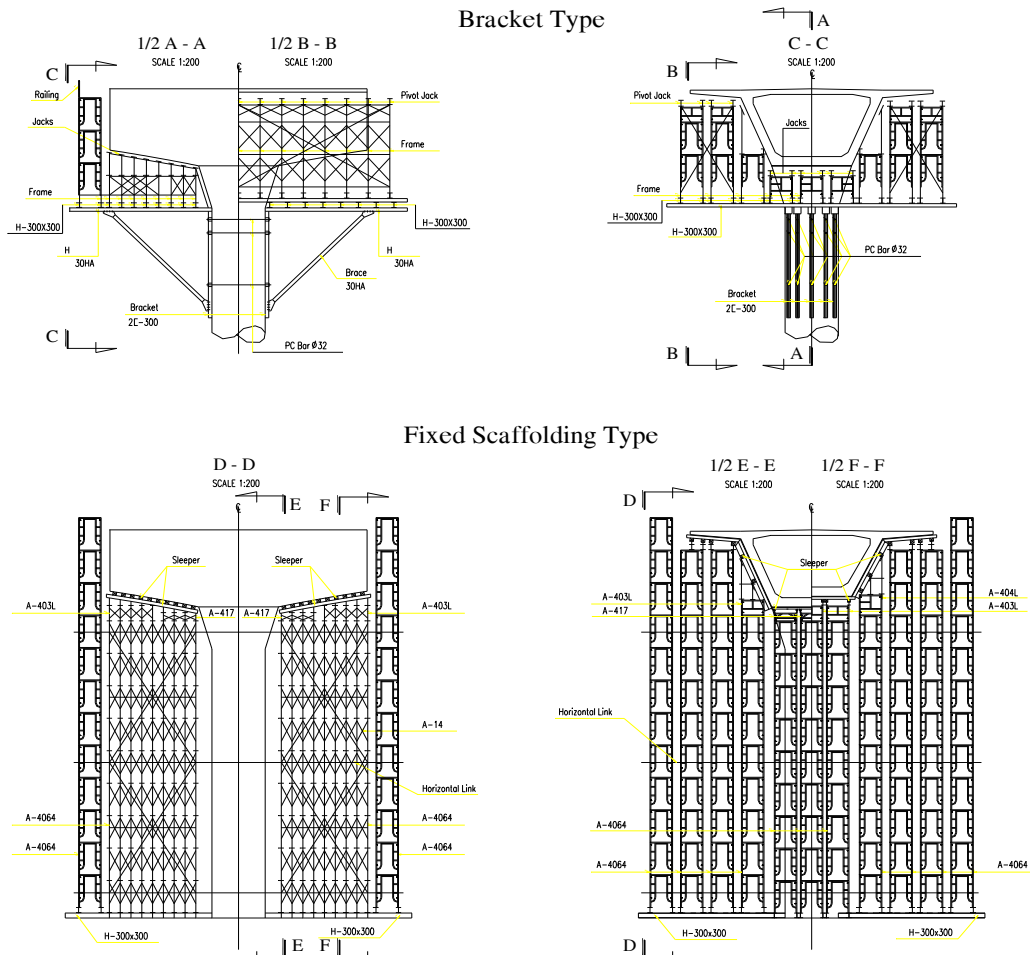


Figure 10-9 Construction of Girder Side Spans

**(4) Construction of Girder Side Spans**

Most of the side spans shall be constructed by cantilevering, but small sections may remain to be constructed by other means, where the economical span lengths are such that cantilevering can not be executed for the entire side span. The remaining portion of the side-spans, therefore, must be executed either by bent- type scaffolding or by pre-fabricated scaffolding frames.

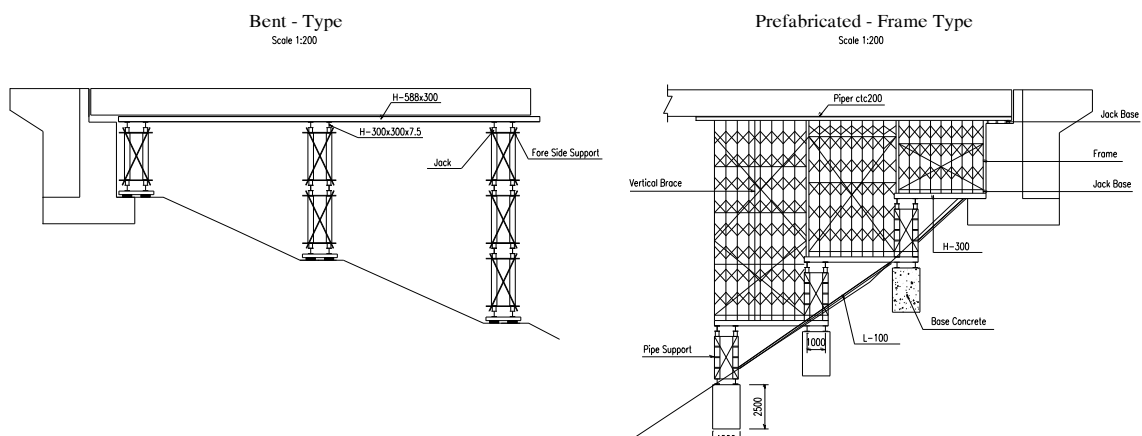
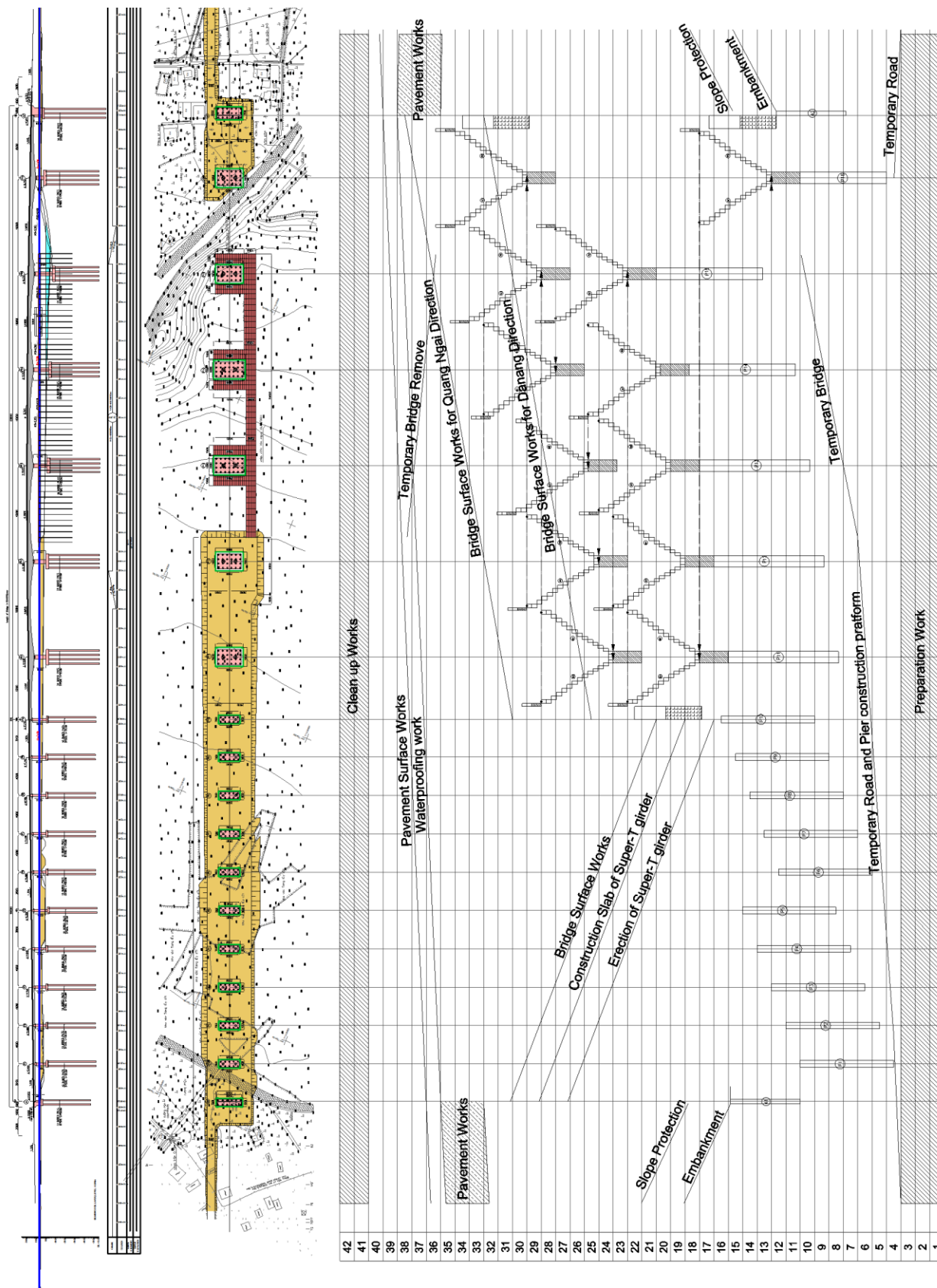


Figure 10-10 Construction of Girder Side Spans

### 10.5 Construction Schedule

The construction schedule is shown below.



## **11 Cost Estimation**

### **11.1 Application Standard and Related Laws and Regulations**

#### **(1) Construction expenses guideline**

- Circular No. 04/2010/TT-BXD on 26/5/2010 of Ministry of Construction on Formulation and management manual of investment construction expenses.

#### **(2) Cost Estimate Standard and Laws**

- Decision No. 957/QĐ-BXD dated 29/9/2009 of Ministry of Construction announcing standard rates of management and consultancy cost of construction investment project.
  - Capital construction norms for work construction part: refer to the norms enclosed to the letter No. 1776/2007/BXD-VP dated 16 August 2007 of the Ministry of Construction.
  - Capital construction norms for installation part: refer to the norms enclosed to the letter No. 1777/2007/BXD-VP dated 16 August 2007 of the Ministry of Construction.
  - The norm on matenance of public lighting system No. 2274/BXD-VP dated November 10, 2008 of the Ministry of Construction.
  - Document No. 2565/BXD-KTCL dated 29/11/2006 on application of traffic safety cost.
  - Letter No. 1784/BXD-VP dated 16 August 2007 of the Ministry of Construction issued the norms for materials.
  - Decision No. 131/2007/QĐ-TTg dated 9/8/2007 of Prime Minister of Vietnamese government about publishing regulation of foreign consultant choosy cost in construction activities in Viet Nam.
  - Decision No. 33/2004/QĐ-BTC dated 12/4/2004 of Ministry of Finance about insuarance fee.
  - Decree No. 123/2008/ND-CP dated 08/12/2008 of Vietnamese Goverment about VAT law
- Circular No. 194/2010/TT-BTC of December 6, 2010, guiding customs procedures; customs inspection and supervision; import duty, export duty and tax administration applicable to imports and exports (MOF)

#### **(3) Material Price**

- Declaration on material price No.764/SXD-QLXD 15th March 2012, in Da Nang City
- Declaration on material price No.1773/CB-LS Q4/2011in Quang Nam Province
- Declaration on material price No.841/SXD-KTKHXD 07th Feb 2012 in Quang Ngai Province

#### **(4) Machine Price**

- Letter 325/2008/UBND-QLĐT date 16 Jan 2008, Estimated price list of machine shift in Da Nang City
- Decision No 2236/2006/QĐ-UBND date 01 Aug 2006 and Decision No 3075/2006/QĐ-UBND date 30 Oct 2006, Estimated price list of machine shift in Quang Nam Province
- Decision No.70/2006/QĐ-UBND Date 28 Nov 2006, Estimated price list of machine shift in Quang Ngai Province

### **11.2 Construction Cost Structure**

Construction cost structure is base on the current Vietnamese standard, Circular No 04/2010/TT-BXD dated May 26, 2010 and issued by the Ministry of Construction (MOC).

Table 3.6. CONSTRUCTION EXPENSES SUMMARY IS CALCULATED CONSUMPTION OF MATERIAL, LABOR AND MACHINE AND CORRESPONDED PRICE TABLE

ORD	CONTENT OF EXPENSES	FORMULA	AMOUNT	SYMBOL
I	DIRECT EXPENSES			
1	Material expenses	From table 3.5		VL
2	Labor expenses	From table 3.5		NC
3	Machine expenses	From table 3.5		M
4	Other direct expenses	$(VL+NC+M) \times \text{tỷ lệ}$		TT
	Direct expenses	$VL+NC+M+TT$		T
II	General Expenses	$T \times \text{rate}$		C
III	Pre-Determined Taxable Income	$(T+C) \times \text{rate}$		TL
	Pre-tax construction expenses	$(T+C+TL)$		G
IV	VAT	$G \times T^{GTGT-XD}$		GTGT
	After-tax construction expenses	$G + GTGT$		$G_{XD}$
V	Expense for Building make-shift House on Construction Sites for Accommodation and Construction Management	$G \times \text{rate} \times (1 + T^{GTGT-XD})$		$G_{XDNT}$
	<b>TOTAL</b>	$G_{XD} + G_{XDNT}$		

The adoption rate of each item is as follows by regulation of Circular No 04/2010/TT-BXD.

**Table 11-1 Adoption Rate of Construction Expenses**

Item	Rate
Other direct expenses	2.0%
General Expenses	5.5%
Pre-Determined Taxable Income	6.0%
VAT	10%
Expense for Building make-shift House on Construction Sites for Accommodation and Construction Management	2.0%

### 11.3 Currency and Exchange Rate

US dollar (USD) is used as F/C while Vietnamese Dong (VND) is used as L/C in this detail design.

The exchange rate used of this BD: 1USD = 20,000VND, 1USD = 77JPY

1JPY = 260VND

### 11.4 Construction Cost

#### (1) Structure of Construction Cost

Composition of Bill item of construction cost is made into the following item from the classification of road structure.

**Table 11-2 Structure of Bill item of Project cost**

Bill Item No.	Bill Item
<b>A</b>	<b>General</b>
<b>B</b>	<b>Road Works</b>
	B1 Expressway
	B2 Frontage Road
<b>C</b>	<b>Bridge Works</b>
	C1 Superstructure
	C2 Substructure

<b>D</b>		<b>Provisional Sums</b>
<b>E</b>		<b>SUB TOTAL, A+B +C+D</b>
<b>F</b>		<b>Physical Contingency, 15% of E</b>
<b>G</b>		<b>TOTAL, E+F</b>

## 11.5 Construction Cost

### BID PRICE SUMMARY

Detailed Design for Danang-Quang Ngai Expressway Development Project

IDA Credit No.3843-VN

PACKAGE 3A (Km16+880~Km18+100) : Ky Lam Bridge

BILL NO	CONSTRUCTION ITEMS	FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	TOTAL COMBINED (VND)
<b>A</b>	<b>General Requirements</b>		<b>96,809,799,249</b>	<b>96,809,799,249</b>
<b>B</b>	<b>Road Works</b>		<b>33,906,503,000</b>	<b>33,906,503,000</b>
	B1 Expressway		33,906,503,000	33,906,503,000
	1. Site Worka		1,620,200,000	1,620,200,000
	2. Earth Works		24,761,620,000	24,761,620,000
	3. Drainage Works		100,000,000	100,000,000
	4. Pavement Works		3,735,053,000	3,735,053,000
	5. Road Furniture and Miscellaneous		3,689,630,000	3,689,630,000
<b>C</b>	<b>Bridge Works</b>		<b>1,175,928,821,880</b>	<b>1,175,928,821,880</b>
	C1 Superstructure		538,172,702,400	538,172,702,400
	1. Asphalt Products and Pavement		8,330,640,000	8,330,640,000
	2. Concrete		528,103,322,400	528,103,322,400
	3. Steel Works		1,738,740,000	1,738,740,000
	C2 Substructure		637,756,119,480	637,756,119,480
	1. Earth Works		54,404,016,000	54,404,016,000
	2. Concrete Works		583,352,103,480	583,352,103,480
<b>D</b>	<b>Provisional Sums</b>			
<b>E</b>	<b>SUB TOTAL, A+B +C+D</b>		<b>1,306,645,124,129</b>	<b>1,306,645,124,129</b>
<b>F</b>	<b>Physical Contingency, 15% of E</b>		195,996,768,619	195,996,768,619
<b>G</b>	<b>TOTAL, E+F</b>		<b>1,502,641,892,748</b>	<b>1,502,641,892,748</b>

- (i) Foreign Currency Component of Bid Price, written in words:
- (ii) Local Currency Component of Bid Price, written in words:
- (iii) VN Dong Equivalent of Combined Total Bid Price, written in words:
- (iv) Exchange rate as specified by the Employer, used to convert the foreign currency component to Vietnam

## 11.6 Comparison with FS construction costs

Comparison with FS construction costs is shown in the following table.

**Table 11-3 Summary of Comparison Construction Cost Between BD and FS**

Item	BD Cost	BD Cost by FS Unit Price	FS Cost	Balance	The factor of construction costs change			
					Quantities Change	Lack of Item and Quantity	Change of Unit Price	Total
	(A)	(B)	(C)	(D)=(A)-(C)	(E)=(B)-(C)			
<b>General Requirements</b>	96,810	0		96,810	0	96,810	0	96,810
<b>Road Works</b>	33,907	15,580	13,067	20,840	2,513	1,633	16,694	20,840
B1 Expressway	33,907	15,580	13,067	20,840	2,513	1,633	16,694	20,840
1. Site Works	1,620	95	0	1,620	95	188	1,337	1,620
2. Earth Works	24,762	11,575	7,374	17,387	4,201	0	13,186	17,387
3. Drainage Works	100	0	0	100	0	100	0	100
4. Pavement Works	3,735	3,239	4,392	-657	-1,153	0	496	-657
5. Road Furniture and Miscellaneous	3,690	671	113	3,577	558	1,345	1,674	3,577
Construction auxiliary			1,188	-1,188	-1,188	0	0	-1,188
<b>Bridge Works</b>	1,175,929	963,177	791,392	384,537	171,785	9,762	202,990	384,537
C1 Superstructure	538,173	278,085	460,750	77,423	-182,665	6,147	253,940	77,423
1. Asphalt Products and Pavement	8,331	6,353	3,216	5,115	3,138	0	1,978	5,115
2. Concrete	528,103	271,334	389,584	138,519	-118,251	4,800	251,969	138,519
Construction auxiliary			1,548	-1,548	-1,548	0	0	-1,548
3. Super-T girder			60,074	-60,074	-60,074			-60,074
Construction auxiliary			6,007	-6,007	-6,007			-6,007
4. Steel Works	1,739	398	305	1,433	93	1,347	-7	1,433
Construction auxiliary			15	-15	-15	0	0	-15
C2 Substructure	637,756	685,092	330,641	307,115	354,450	3,614	-50,950	307,115
1. Earth Works	54,404	10,586	1,354	53,050	9,232	22	43,796	53,050
2. Concrete Works	583,352	674,506	146,665	436,687	527,841	3,592	-94,746	436,687
Construction auxiliary		0	29,604	-29,604	-29,604	0	0	-29,604
3. Super-T girder		0	139,108	-139,108	-139,108	0	0	-139,108
Construction auxiliary		0	13,911	-13,911	-13,911	0	0	-13,911
<b>TOTAL DIRECT COST</b>	1,306,645	978,757	804,458	502,187	174,298	108,204	219,684	502,187
				62%	22%	13%	27%	

The construction cost of PKG3A was set to 1,307 billion VND, and became 1.62 times higher than FS construction costs.

The reason for an increase of construction costs is as follows.

➤ **Increase of a unit price by the rise of the price index**

According to the price index report of MOC, price increases are 24% - 35% by BD (III/2011) from FS (II/2010). The price index of the unit price in PKG3A is 27%.

The price index of material and the price index of construction cost are shown in reference below.

**Table 11-4 Publication Price Index of Construction Area (Danang)**

A	Material	Materials price indexes		
		quarter 2.2010/2006	quarter 3.2011/2006	quarter 3.2011 /quarter 2.2010
STT				
1	Cement	135.54	185.67	136.99%
2	Sand	177.69	257.23	144.76%
3	Stone	179.75	226.13	125.80%
4	Wood	122.22	127.78	104.55%
5	Reinforcing	180.88	214.12	118.38%
6	Bitum	218.41	263.55	120.67%
7	water sector	157.71	232.17	147.21%
B	<b>Labour</b>	234.12	319.26	136.37%
C	<b>Machine</b>	140.29	161.33	115.00%

Souse: MOC Report 778/QD-BXD (20/08/2010), 950/QD-BXD (31/10/2011)

**Table 11-5 Price Index of Construction (Traffic Works)**

D	ITEM	quarter 2.2010/2006	quarter 3.2011/2006	quarter 3.2011 /quarter 2.2010
1	Highway construction			
-	Concrete road	173.40%	224.52%	129.48%
-	Asphalt Concrete road.	183.83%	232.67%	126.57%
2	Bridgework, Tunnel work			
-	Bridge, reinforced concrete culvert, Tunnel	178.69%	221.60%	124.01%

Souse: MOC Report 778/QD-BXD (20/08/2010), 950/QD-BXD (31/10/2011)

➤ **Increase of construction cost by change of bridge structure component**

In BD, the structure type of the bridge was changed as follows.

FS: PC Box girder 65+5@100+65 and Super-T girder 8@40 Total length = 950m

BD: PC Box girder 65+5@100+65 and Super-T girder 10@40 Total length = 1030m

The construction cost of the bridge computed on a FS unit price basis is as follows.

**Table 11-6 Comparison Table of Construction Ky Lam Bridge**

ITEM		FS cost (million VND)	BD cost (million VND)
Superstructure	Bridge type	PC Box girder 65+5@100+65 and Super-T girder 8@40 Total length = 950m	PC Box girder 65+5@100+65 and Super-T girder 10@40 Total length = 1030m
	Box girder	394,669	418,842
	Super-T	66,082	119,331
	Sub-total	460,750	538,173
Substructure			
	Box girder	177,622	335,017
	Super-T	153,019	302,739
	Sub-total	330,641	637,756
Total		791,392	1,175,929
Balance			<b>384,537 (48.5%)</b>
Include:			
The correction price by the price index		Price Index = 25.6%	<b>202,990 (25.6%)</b>
The balance by lack of quantity and unit price structure			<b>9,762 (1.2%)</b>
The balance by the difference in bridge structure composition			<b>171,785 (21.7%)</b>

## 12 Conclusions

### 12.1 Basic Design Result

Basic design has been conducted for the optimum bridge scheme selected through the alternative study as well as series of meeting between MOT, VEC, PMU and the Consultant.

Finally Alternative 3 A was selected due to a limitation of the budget.

**Table 12.1 Features of Ky Lam Bridge (Basic Design Study)**

No.	Items	Alternative (Proposed Plan)
1	Station (Bridge Section)	KM017+492
2	Bridge Length	1,030m (Girder Length)
3	Bridge Width	26m (Initial Stage: 4 lanes)
4	Span Arrangement	10@40m+65m+5@100m+65m
5	Superstructure Type	Super Tee Girder + Continuous PC Box Girder
6	Support Conditions	Rigid frame : center 2 spans of PC box Fix condition: Elastomeric bearings Move condition: Pot bearings
7	Navigational Clearance	6m x 30m (6m x 50m in consideration of 45 degree of skew)
8	Pier Shape	Circular type

Basic Design Drawings of Road Embankment and Bridge is in Appendix 5 & 6 respectively.

### 12.2 Issues to be Examined in the Detail Design Stage

Following studies shall be carried out in the D/D stage:

- Geotechnical investigations
- Determination of support conditions
- Analysis of river bank erosion and scouring
- Design of the river protection works

**Appendix 1: Discussion Paper of Alternative Study Report (Ky Lam  
Bridge) (Rev. 2) (04 January 2012)**





*Ministry of Transport*



*Vietnam Expressway Corporation*



*Project Management Unit No. 85*



THE WORLD BANK

**IDA Credit No. : 3843-VN**

**Project ID No. : P106235**

**Consulting Services  
for  
Detailed Design for Danang - Quang Ngai Expressway Development Project**

**Discussion Paper  
Alternative Study Report (Ky Lam Bridge)**

**(Revision 2)**

**January 04, 2012**

The Joint Venture of  
Nippon Koei Co., Ltd.  
Nippon Engineering Consultants Co., Ltd.  
Chodai Co., Ltd.  
Thai Engineering Consultants Co., Ltd

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

IDA Credit No. : 3843-VN

Project ID No. : P106235

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Ref. No. : DQEDD-PMU85-03-11

Date : January 4, 2012

**Mr Nguyen Tien Ha**

Project Manager

Project Management Unit 85

Fax. No. : +(84) 511-3642-914

**Subject: Discussion Paper for  
Alternative Study Report (Ky Lam Report) (Revision 2)**

Dear Sir,

The reference is made to:

- Our Letter DQEDD-PMU85-87-11 dated 21 December 2011;
- Our Letter DQEDD-PMU85-93-11 dated 23 December 2011.

We would like to submit three (03) copies of the Alternative Study Report (Ky Lam Bridge) (Revision 2) in English and Vietnamese version, respectively for your review and comment.

In this Revision 2, Part 5 "Additional Alternatives based on the Comments on the Revision 1 of the Alternative Study Report for Ky Lam Bridge" is additionally provided in accordance with the meeting among the representatives of VEC, PMU85, PMU1, TEDI and the Consultant held in Ha Noi on December 27, 2011.

Your timely review and comments will be highly appreciated.

Sincerely yours,

---

Ichizuru ISHIMOTO

Project Manager

Enclosed:

- Discussion Paper for Alternative Study Report (Ky Lam Bridge)(Revision 2) (English: 3 copies;  
Vietnamese: 3 copies)

C.C: - PMU85, Vinh +(84 38) 383-4705

- Bridge Design Team

- Office Copy

Letter of Submission  
Project Location Map

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## **Abbreviations**

D/D : Detailed Engineering Design  
DHWL : Design High Water Level  
F/S : Feasibility Study  
MOT : Ministry of Transport  
NH : National Highway  
PC : Pre-stressed Concrete  
PKG : Package  
WB : The World Bank

## 1 General

### 1.1 Objectives

The objective of this alternative study is to propose the optimum bridge plan of Ky Lam Bridge for the review and comments of PMU85 and relevant organizations for the finalization of the Basic Design Report (Civil PKG3A).

### 1.2 Location

The Ky Lam Bridge is the main component of Package 3A and is crossing the Thu Bon River at KM017+492 on the Project road in Quang Nam Province (see the Project Location Map).

### 1.3 Pre-conditions

The construction works of the Project is required to be commenced in September 2012 in accordance with the Minutes of the 2nd Contract Negotiation dated on October 15, 2011. In response to this requirement, Package 3A; Ky Lam Bridge section, was proposed as the 1st priority in the procurement plan prepared by the Consultant and it is under review and approval processes by relevant organizations.

In consideration of the above urgency, this alternative study was conducted prior to a submission of several reports which define the fundamental conditions for this alternative study. In this regard, the pre-conditions for this alternative study were summarized as shown in Table 1.

**Table 1 Pre-conditions for This Alternative Study**

No.	Reports in the Service		Work Progress	Applied Pre-conditions in This Study
1	General Reports	Review Report (Civil)	On-going	Followed draft review results
2		Detailed Engineering Design Framework	On-going	Applied MOT Decision No. 362/QD-BGTVT
3	Survey Reports	Control Point and Topographic Surveys Report	On-going	Used topographic survey results
4		Hydrological/Inundation Analyses Report (Danang/Quang Nam)	On-going	Referred F/S data
5		Geotechnical and Geological Investigations Report	Not commenced	Referred F/S data
6	Technical Reports	Design Criteria and Conditions (Civil 1)	On-going	Applied draft design criteria and conditions
7		Typical Cross Sections	On-going	Applied draft study results
8		Geometric Design (Thruway, PKG3A)	On-going	Applied draft geometric design
9		Revetment/River Bed Protection Design (PKG3A)	Not commenced	Not studied details in this study
10	Discussion Papers	Alternative Alignment Study Report	On-going	Followed draft study results
11		Cross Structure Plan	On-going	Followed draft cross structure plan

### 1.4 Summary of the Study Results

By reviewing previous studies, mainly the F/S report, following issues were identified and discussed on the bridge plan of Ky Lam Bridge mainly to cope with the secular variation of river channel of the Thu Bon River.

- Typical cross sections to be re-examined (in consideration of the future widening)
- Abutment locations to be re-examined
- Pier type and locations to be re-examined
- The number and location of navigational clearance to be re-examined
- Span arrangement to be re-examined

Based on several site investigations, re-examinations and discussions with relevant organizations, the Consultant recommends the alternative plan of Ky Lam Bridge as shown in Table 2.

**Table 2 Summary of Alternative Bridge Plan of Ky Lam Bridge**

No.	Items	F/S (Original Plan)	Alternative (Proposed Plan)
1	Station (Bridge Section)	KM017+662	KM017+492
2	Bridge Length	950m (Girder Length)	1,030m (Girder Length)
3	Bridge Width	26m (Initial Stage: 4 lanes)	31m (Initial Stage: Complete 6 lanes)
4	Span Arrangement	4@40m+65m+5@100m+65m+4@40m	65m+9@100m+65m
5	Superstructure Type	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder	PC Box Girder
6	Navigational Clearance	6m*40m (6m*75m in consideration of 30 degree of skew)	6m*40m (6m*60m in consideration of 45 Degree of Skew)
7	Pier Shape	Wall type	Circular type

### **1.5 Next Step to the Final Bridge Plan**

It shall be noted that the alternative bridge plan proposed in this alternative study report will be finalized in accordance with the remaining fundamental conditions which will be given by the reports as listed in Table 1, and will be submit as a part of Basic Design Report (Civil, PKG3A).

## 2 Previous Studies Review

### 2.1 Outline of the F/S Report

#### 2.1.1 Location

The Ky Lam Bridge in the F/S is located at KM017+662 (bridge center) on the Project road and is crossing at approximately 200m upstream from the existing railway bridge on the Thu Bon River as shown in Figure 1.

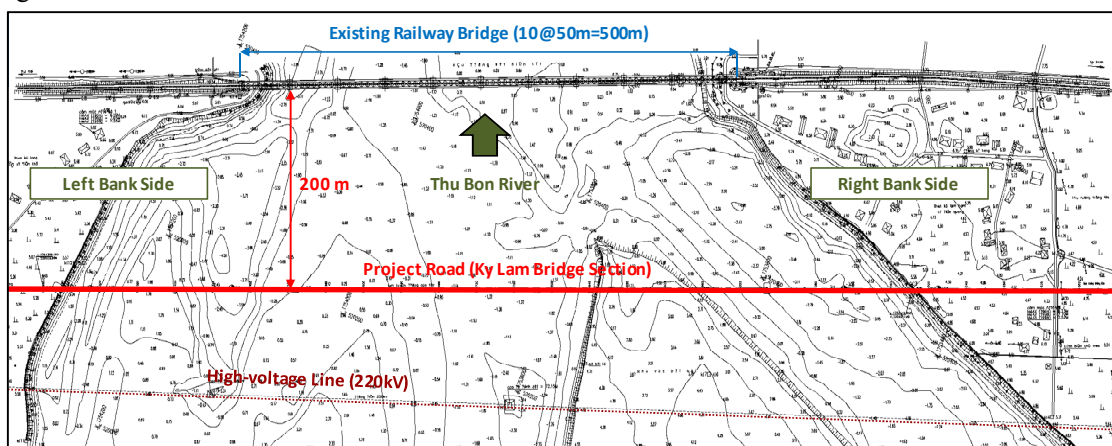


Figure 1 Location of Ky Lam Bridge

#### 2.1.2 Main Features

Main features of Ky Lam Bridge in the F/S are summarized in Table 3.

Table 3 Main Features of Ky Lam Bridge in the F/S

No.	Items	Main Features	Remark
1	Station (Bridge Center)	KM017+662	
2	Road Class/Design Speed	Road Class: Type A, Class 120, Design Speed: 120km/h	
3	Nos. of Lane/Road Width	Nos. of Lane: 4 lanes, Road Width: 26m	Ultimate Stage: Widened to 6 Lanes
4	Hydrological Requirements	DHWL: 8.66m (H1%), Free Board: 1m, Required Opening Length: 930m	
5	Navigational Clearance	River Class: Class IV, Navigational Clearance: 6m*40m, DHWL: 8.02m (H5%)	Widened to 6m*75m by 30 degree of Skew
5	Bridge Length/Span Arrangement	Bridge Length: 970.4m, Span Arrangement: 4@40m+65m+5@100m+65m+4@40m	
6	Superstructure	Main Span: PC Continuous Box Girder, Approach Span: PC Super Tee Girder	
7	Abutment	Inverted T-shape	Abutment: h=14m, Embankment: h=12m
8	Pier	Wall type	
9	Foundation	Cast in place RC pile (L=40m, Piers: $\phi$ 1.5m, Abutment: $\phi$ 1.0m)	

#### 2.1.3 Typical Cross Sections

Typical cross sections of Ky Lam Bridge in the F/S are shown in Figure 2.

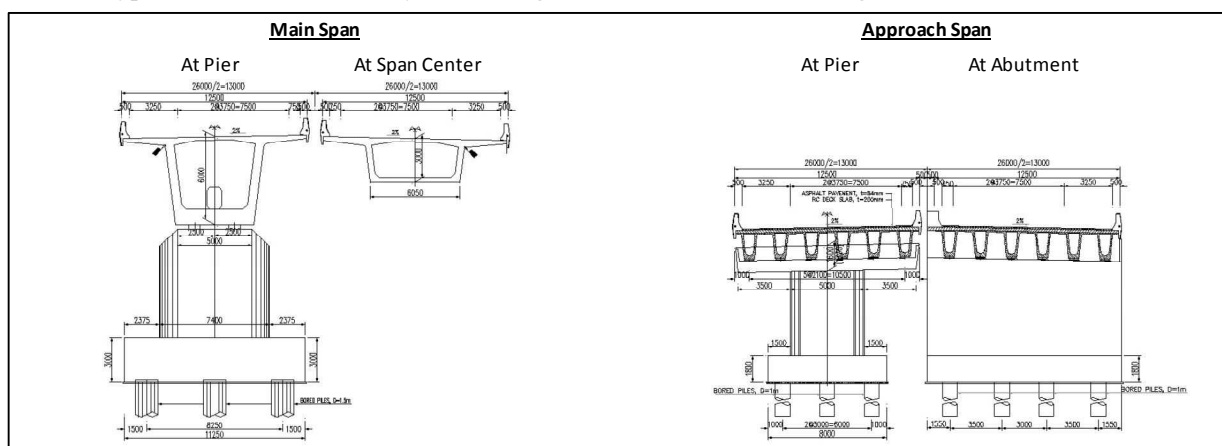


Figure 2 Typical Cross Section of Ky Lam Bridge in the F/S

#### 2.1.4 Drawings

General view of Ky Lam Bridge in the F/S is shown in Figure 3.



## 2.2 Comments on the F/S Report

Comments on each technical item in the F/S report are described below:

### 2.2.1 Cross Sections

#### (1) The F/S Report

The typical cross section of thruway in the F/S was determined to be 26m with 4 lanes for the initial stage and will be widened to 6 lanes in the ultimate stage according to MOT Decision No. 2656/QD-BGTVT. However, the cross section elements in the ultimate stage were not determined in the MOT Decision.

According to the F/S Consultant, the widening of the bridge structure in the future was not considered and it was planned to reduce the carriageway width from 3.75m to 3.5m without emergency lanes for securing 6 lanes in the ultimate stage as shown in Figure 4.

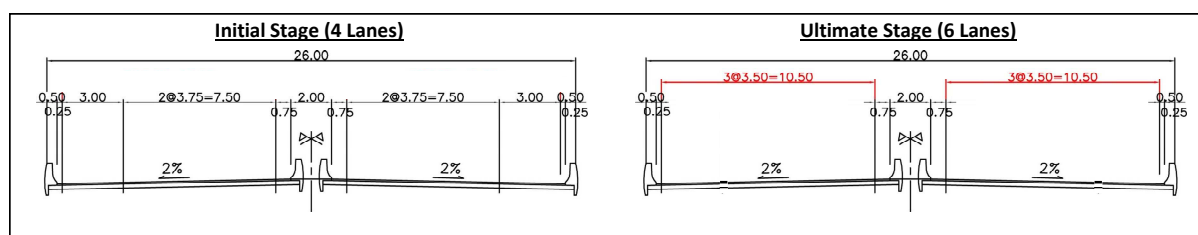


Figure 4 Typical Cross Section of Ky Lam Bridge in the F/S

#### (2) Issues and Comments on the F/S

##### (a) Cross Sectional Elements

The cross sectional elements of the bridges in the F/S are as shown in Table 4.

Table 4 Cross Section Elements of Thruway in the F/S

Cross Section Elements	Initial Stage			Ultimate Stage		
	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	2.00	2.00	1	2.00	2.00
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50
Carriageway	4	3.75	15.00	6	<u>3.50</u>	21.00
Marginal Strip (Outer)	2	0.75	-	2	0.75	-
Shoulder (Emergency Lane)	2	3.00	6.00	<u>0</u>	-	-
Soft Shoulder						
Parapet	2	0.75	1.50	2	0.75	1.50
Pedestrianway						
Total			26.00			26.00

Note: Underlined values are non-standard or exceptional case

For some cross sectional elements of thruway in the F/S, non-standard or exceptional values are applied against the TCVN5729-1997 as shown in Table 4:

Since the Project road is primary arterial to support regional economical and industrial activities and being developed to provide high-speed transport service (design speed 120km/h), the Project road shall fulfill high traffic function and high traffic safety. The Consultant examined the value of cross sectional elements for the non-standard and exceptional value in the F/S in accordance with TCVN5729-1997 as shown in Table 5.

**Table 5 Examination Results for Cross Section Elements at the Ultimate Stage of Ky Lam Bridge in the F/S**

Cross Section Elements	Standard Value	F/S Value	Major Function		Recommended Value	Comments
			Traffic	Spatial		
Carriageway	3.75m	3.50m	<ul style="list-style-type: none"> <li>To provide appropriate traveled way width to conform necessary width for vehicle regulation and vehicle passage, as well as vehicle speed (3.75m)</li> </ul>		3.75m	3.75m width of carriage way shall be provided to ensure level of service and traffic safety.
Median	3.0m	2.0m	<ul style="list-style-type: none"> <li>Directional traffic separation for accident prevention (0.5m to 0.75m)</li> <li>Glaring mitigation for accident prevention</li> </ul>	<ul style="list-style-type: none"> <li>Space for guard separator (0.5m to 0.75m)</li> <li>Space for planting ( up to 1.5m)</li> <li>Space for bridge pier (up to 2.0m)</li> </ul>	2.0m	2.0m width fulfills necessary functions and reduce project cost
Shoulder (including Outer Marginal Strip)	3.0m (2.0m*)	0.0m	<ul style="list-style-type: none"> <li>To accommodate stopped vehicle, emergency vehicle, maintenance operation space (1.25m to 3.0m)</li> <li>Space for indication of traveled way boundary, provision of marginal traveled way for evasive maneuvers (0.75m)</li> <li>Structural lateral support of pavement (0.50m to 0.75m)</li> </ul>		2.0m	3.0m width of shoulder shall be provided to bridge sections to fulfill necessary functions. However, exceptional value of 2.0m shoulder width is applicable for long bridges to reduce project cost

\*exceptional value for long bridges

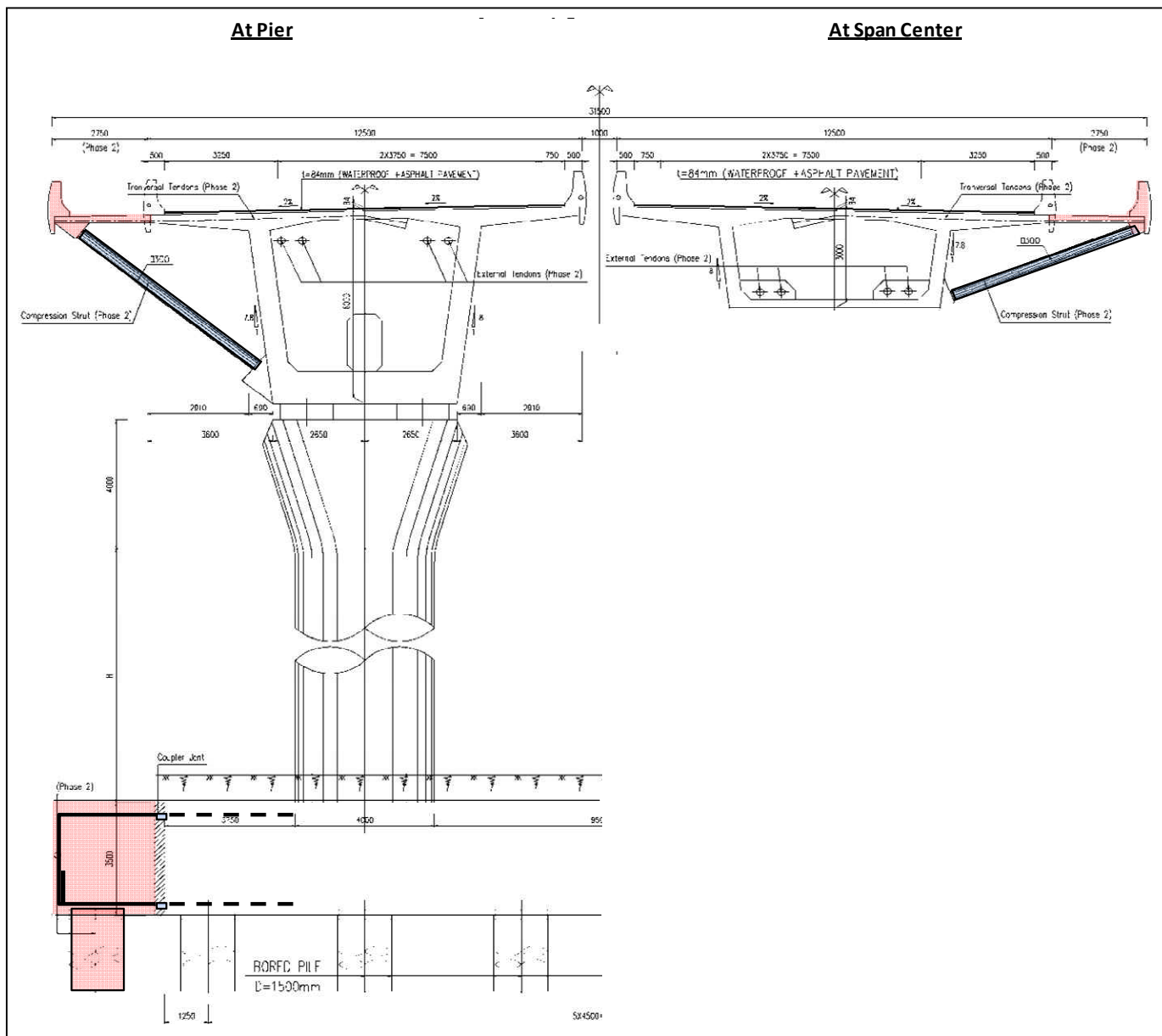
As a result of the examination, revised value of the cross section elements are proposed by the Consultant as shown in Table 6.

**Table 6 Proposed Cross Section Elements**

Cross Section Elements	Initial Stage			Ultimate Stage		
	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	2.00	2.00	1	2.00	2.00
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50
Carriageway	4	3.75	15.00	6	3.75	22.50
Marginal Strip (Outer)	2	0.75	-	2	0.75	-
Shoulder (Emergency Lane) for Short/Medium Bridge ( $L < 100m$ )	2	3.00	6.00	2	3.00	6.00
Shoulder (Emergency Lane) for Long Bridge ( $L \geq 100m$ )				2	2.00	4.00
Parapet	2	0.50	1.00	2	0.50	1.00
Total			25.50	Bridges ( $L < 100$ ):		33.00
				Bridges ( $L \geq 100m$ ):		31.00

**(b) Structural Aspect**

An example of future widening works for PC box girder is shown in Figure 5. Although it is theoretically possible, in consideration of durability, structural balance, and constructability in major river locations, PC box girder bridges in the Project are strongly recommended to construct complete 6 lanes in the initial stage.



**Figure 5 Image of Widening for PC Box Girder Bridge (UNREASONABLE)**

**(3) Recommendations**

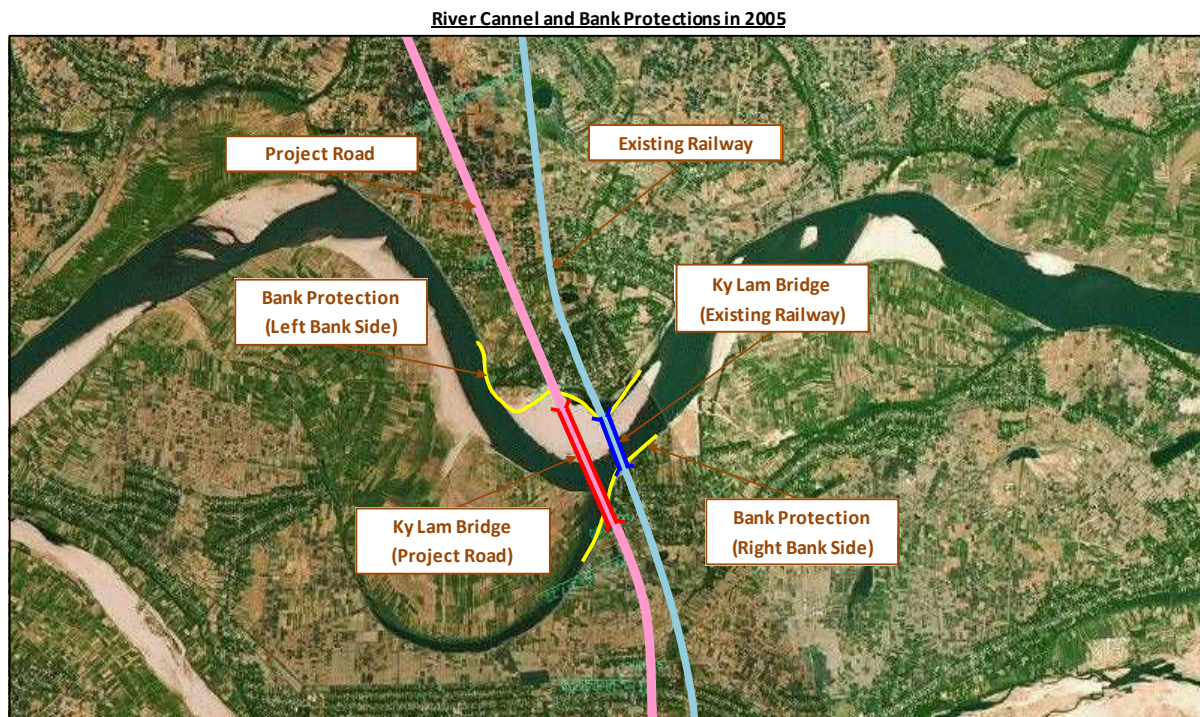
The Consultant strongly recommends the following alternative to the F/S:

- PC Box Girder Bridge shall be completed in 6 lanes in the initial stage.

**2.2.2 Abutment Locations**

**(1) The F/S Report**

The bridge length for Ky Lam Bridge in the F/S explained that it was considered the secular variation of river channel of the Thu Bon River. However, the abutment at the left bank side was planned within the river area because the existing bank protections is located much left side of the planned abutment as shown in Figures 6 and 7.



**Figure 6 Secular Variation of River Channel in Thu Bon River**

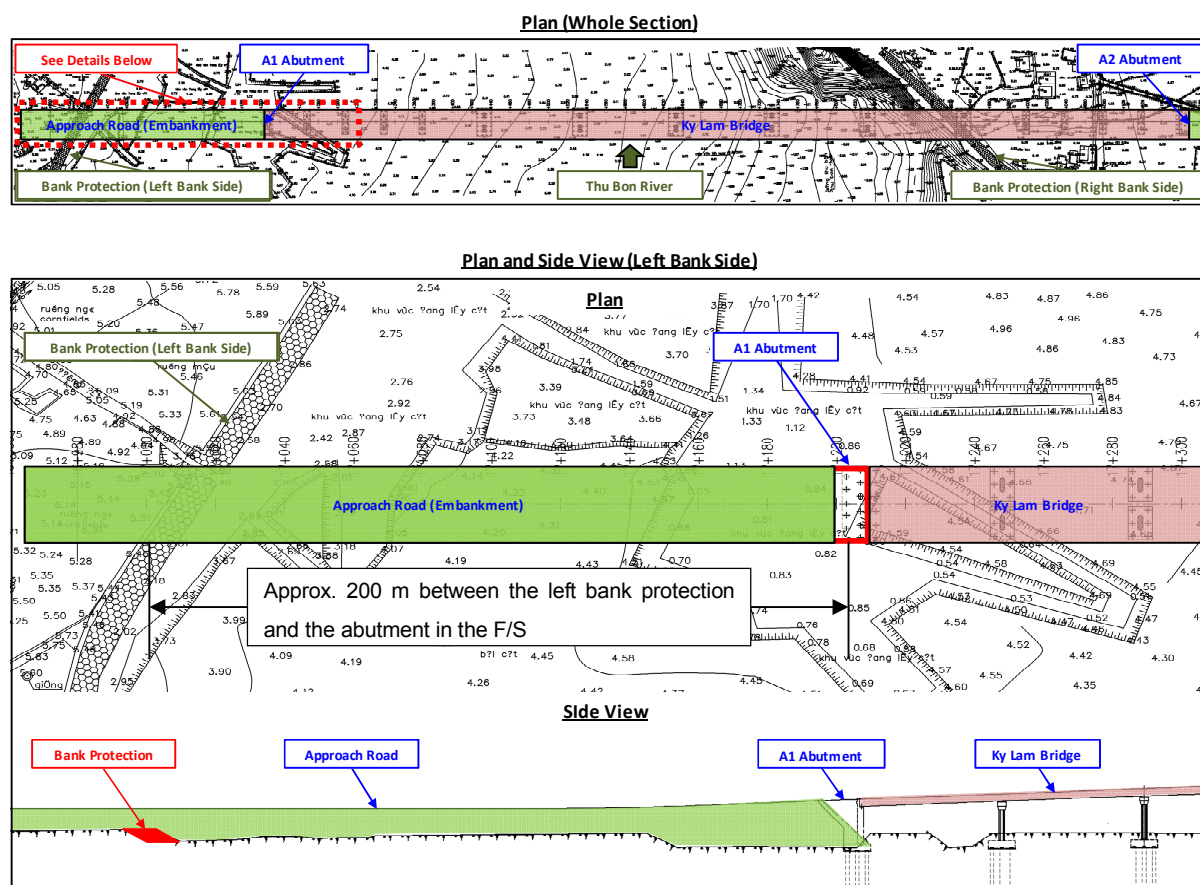


Figure 7 Abutment Locations in the F/S Plan

## (2) Issues and Comments on the F/S

### (a) Secular Variation Range of River Channel

It is reasonable to define the length of Ky Lam Bridge in consideration of the secular variation of the river channel of the Thu Bon River. However, the secular variation range of the river channel in the F/S was evaluated based on the existing large scale topographic map (1/50,000).

The Consultant conducted site investigations and hearing to the local residents and it was confirmed that the actual historical secular variation range of river channel in the Thu Bon River is between the existing river bank protections on both sides.

### (b) Abutment Location Regulated by River Administration

The left abutment of Ky Lam Bridge in the F/S was located at the river area, 200 m right side from the existing bank protection, as shown in Figure 7.

The Consultant confirmed that the abutment locations of river bridges are not regulated in Vietnam; however, the abutments of Ky Lam Bridge shall be planned outside of the river area to secure the permanent safety flow in terms of the appropriate river administration.

### (c) Required Bridge Opening Length by Inundation Analysis

The Ky Lam Bridge is on a floodplain; however, inundation analysis was not conducted in the F/S stage. The Consultant will determine the required bridge openings by an inundation analysis which is on-going at this moment.

## (3) Recommendations

The Consultant recommends the following alternatives to the F/S.

- The abutments of Ky Lam Bridge shall be planned to be located at outside of the river area.
- The bridge length of Ky Lam Bridge shall be longer than the distance between the river banks on both sides.

- The required bridge opening length at Thu Bon River will be confirmed by an inundation analysis soon in the Services.

### 2.2.3 Pier Type and Locations

#### (1) The F/S Report

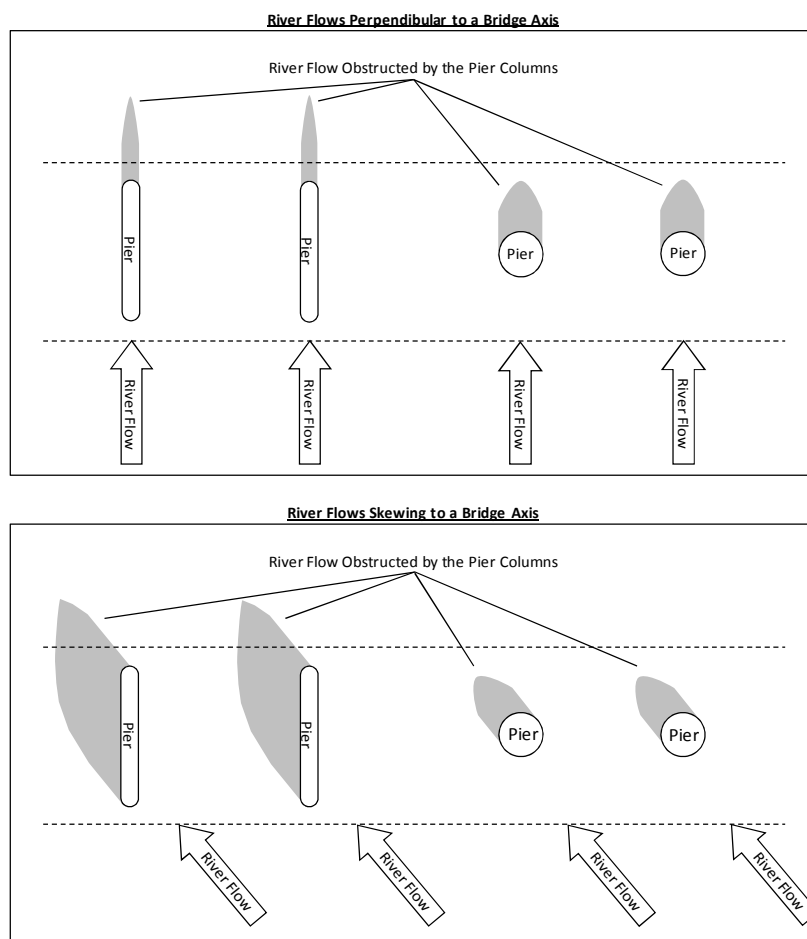
The wall type pier was applied for Ky Lam Bridge in the F/S as shown in Figures 2 to 3. According to the F/S Consultant, the impacts to/from the existing railway bridge were not considered for the planning of pier locations in the F/S stage.

#### (2) Issues and Comments on the F/S

##### (a) Considerations for the Secular Variation of River Channel

The wall type pier was applied for Ky Lam Bridge in the F/S; however, this pier type is not preferable for the secular variation of river channel in general.

The pier type shall be properly selected not to obstacle the river flow; otherwise, serious turbulent will be generated at the pier which causes the critical riverbed scouring at its foundation. Therefore, round-shape type piers are recommended for Ky Lam Bridge to allow any direction of river flow as shown in Figure 8.



**Figure 8 River Flow objected by Wall and Round-shape Piers**

##### (b) Impacts to the Existing Railway Bridge

The impacts to the existing railway bridge were not considered in locating the pier in the F/S.

In general practice in river bridge engineering, 200 m clearance with neighboring bridge is sufficient and no critical impact will be arisen each others.

**(3) Recommendations**

The Consultant recommends the following alternatives to the F/S.

- The round-shape type piers should be applied for Ky Lam Bridge.
- The existing railway bridge is apart from the pier locations of Ky Lam Bridge.

The span arrangement of Ky Lam Bridge was examined in 2.2.5.

### 2.2.4 Navigational Clearance

#### (1) The F/S Report

The navigational clearance of Ky Lam Bridge in the F/S was defined to be 6m\*40m and widened to 6m\*75m in consideration of 30 degree of skew angle at the center span based on the minimum requirement for river class IV in TCVN 5664-1992 as shown in Figure 3.

#### (2) Issues and Comments on the F/S

##### (a) Required Numbers and Location of Navigational Clearance

The navigational clearance of Ky Lam Bridge in the F/S was secured one (1) location at the center span. However, this plan does not consider the secular variation of the river channel of the Thu Bon River.

The Cau Lau Bridge located at the downstream of the Thu Bon River on NH1A Bypass; it seems that the planned location of navigational clearance is on sandbar in the current river conditions due to the variation of river channel as shown in Figure 9. In consideration of this unwelcome situation, the navigational clearance of Ky Lam Bridge shall be secured at anywhere in the river section to deal with the secular variation of river channel in the future.

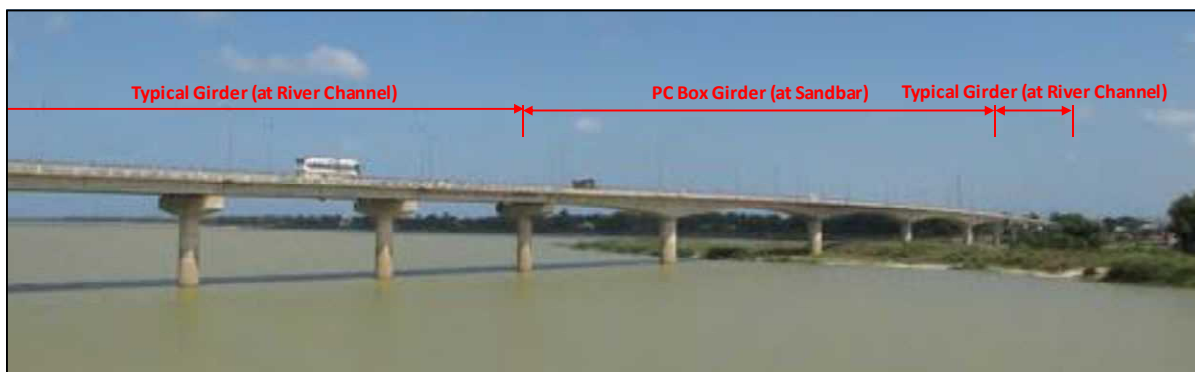


Figure 9 Variation of River Channel at Cau Lau Bridge on NH1A Bypass

##### (b) Required Horizontal and Vertical Navigational Clearance

The navigational clearance of Ky Lam Bridge in the F/S was defined as 6m\*40m and widened to 6m\*75m in consideration of 30 degree of skew angle; however, this assumption is not appropriate in consideration of skew angle between the bridge center line and a direction of river flow.

The navigation course in the current river conditions is located near the right bank where the deepest riverbed is observed and is expected to have the most severe skew flow angle which is approximately 45 degree. Therefore, the horizontal navigational clearance should be 60m based on this skew angle.

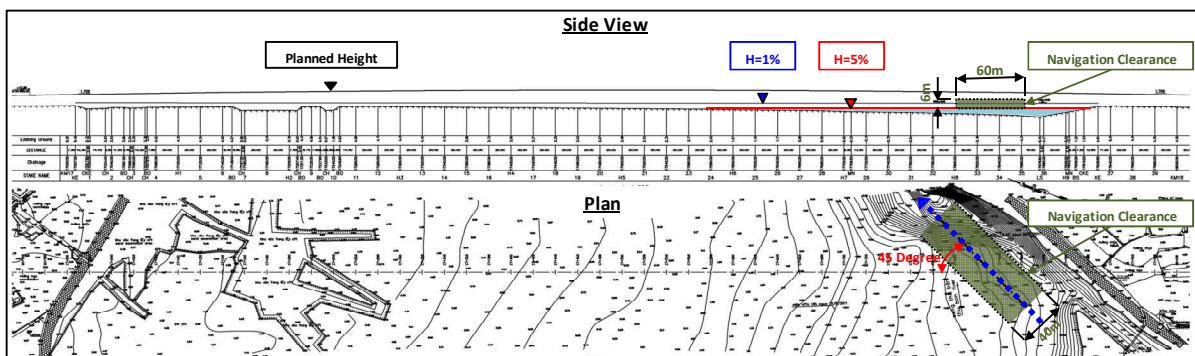


Figure 10 Navigational Clearance in the Current River Conditions

#### (3) Recommendations

- The Consultant proposes the following alternatives to the F/S.
- The navigational clearance of Ky Lam Bridge should be secured at all the spans inside the river area.

- The navigational clearance of Ky Lam Bridge should be 6m\*60m.

It is noted that TCVN 5664-1992 was applied for the technical standard for navigational clearance in this study. The bridge plan will be updated and finalized in accordance with the inundation analysis results as well as TCVN 5664-2009 and will be reported as a part of Basic Design Report (Civil, PKG3A).

## **2.2.5 Span Arrangement**

### **(1) The F/S Report**

The span arrangement of Ky Lam Bridge in the F/S is shown in Table 3 and Figure 3. Followings are confirmed by the F/S Consultant:

#### **(a) The Main Span**

The main span of Ky Lam Bridge was determined based on the location of existing river channel. To select the superstructure type, constructability was prioritized and PC box girder was selected but not typical girders to reduce the number of substructures and their foundations in the river.

The main span length was considered from 70m to 130m based on the economical span lengths for PC box girder in Vietnam. In consideration of adjustability to the length of existing river channel, 100 m long span was selected.

#### **(b) The Approach Span**

The approach span of Ky Lam Bridge was defined as remaining section apart from the main span. The economic aspect in relation to the constructability at onshore was prioritized in the selection of the superstructure type

PC super tee girders with 40m in span length were selected by the following reasons:

- The girders are expected to be fabricated at the construction yards in consideration of the unfavorable transport access conditions from factories to the construction site.
- The equipment cost for casting PC super tee girder is higher than other typical girders; however, in case of large number of girders, the total cost is lower than the other typical girders.
- The span length of PC super tee girder (40m) is the longest in typical girders and the total construction cost can be reduced by small number of substructures and foundations.

### **(2) Issues and Comments on the F/S**

#### **(a) The Required Span Length**

The span length of Ky Lam Bridge shall be more than 60m for all the spans to satisfy the required horizontal navigational clearance as explained in 2.2.4.

#### **(b) The Optimum Span Length**

The economical span length and bridge type was examined based on relevant projects, general practices and hearing from relevant organizations in Vietnam. In case the span length is required to be more than 50m, PC box girder with 70m to 130m length is the most economical solution as shown in Table 7 in the following pages.

### **(3) Recommendations**

The Consultant recommends the following alternatives to the F/S.

- The span length of Ky Lam Bridge is considered to be 70m to 130m for whole river section between the existing bank protections.

## **2.2.6 Abutments**

The embankment height of approach roads of Ky Lam Bridge in the F/S was planned to be 12m and the inverted T-shape type abutment with 14m in height was applied. .

The inverted T-shape abutment is advantageous if its height is less than 15m due to constructability and economic aspects; therefore, the F/S is appropriate. However, the heights of the approach roads and abutments will be re-examined in D/D stage in consideration of boring data.

### **2.2.7 Foundations**

The foundations of Ky Lam Bridge in the F/S is 40m long bored pile with 1.0m to 1.5m in diameter; however, no detail explanation was made in the F/S Report in this regard.

In consideration of the scale of Ky Lam Bridge, the foundation applied in the F/S would be appropriate; however, it shall be re-examined in D/D stage in consideration of boring data.

**Table 7 Economical Span Length and Bridge Type (Span Length=50m to 200m)**

No.	Span Length	Girder Type	Outline Drawing	Main Features	Construction Cost
1	50m to 70m	PC Box Girder (Constant Height)		<ul style="list-style-type: none"> <li>- A stationary supporting or incremental launching method up to 60m in span length, and stationary supporting or cantilever method from 60m to 70m in span length are generally adopted as an erection method.</li> <li>- The stationary supporting method is uneconomical since it requires many import materials and temporary pile foundation in a river.</li> <li>- The incremental launching method is uneconomical since it requires many temporary facilities, especially steels.</li> <li>- The cantilever method is uneconomical in this span length since it requires many form travelers.</li> <li>- This span length with the bridge type is uneconomical in Vietnam since it requires many temporary facilities and more number of piers.</li> </ul>	
2	70m to 130m	PC Box Girder (Variable Height)		<ul style="list-style-type: none"> <li>- This span length with this bridge type is popular in Vietnam.</li> <li>- The cantilever erection method is generally adopted for this span length with this bridge type.</li> <li>- Import materials are limited for this span length, bridge type and erection method.</li> <li>- This span length can reduce the number of piers in comparison with No.1 above.</li> <li>- This span length with bridge type is economical in Vietnam because it reduces temporary facilities, import materials and number of piers.</li> </ul>	
3	More Than 130m	PC Extradozed Girder		<ul style="list-style-type: none"> <li>- This bridge type can secure pre-stressing force to negative bending moment efficiently by utilizing PC strands as external cable.</li> <li>- Girder height of this bridge type can be reduced up to 50% in comparison with No.2 above; therefore, the road profile can be lower.</li> <li>- The cantilever erection method is generally adopted for this span length with this bridge type.</li> <li>- This span length with this bridge type is uneconomical since it requires many PC strands for external cable.</li> <li>- This bridge type requires high-technology for pre-stressing and camber control in construction and maintenance works.</li> </ul>	

### 3 Alternative Bridge Plan

#### 3.1 Pre-conditions

The alternative bridge study of Ky Lam Bridge was made in accordance with the pre-conditions as shown in Table 8. These conditions are included in the proposals to F/S as described in 2.2.

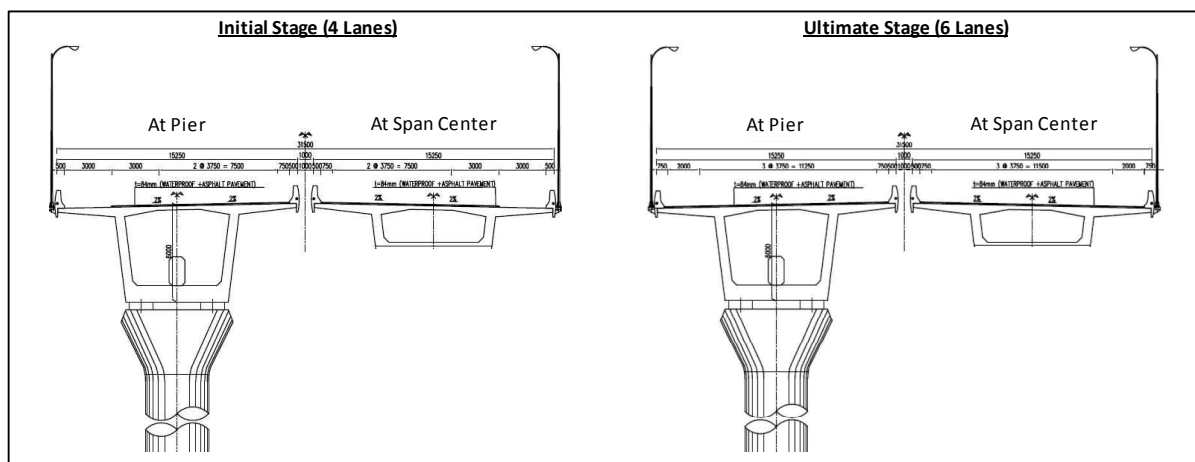
**Table 8 Pre-conditions for Alternative Bridge Plan**

No.	Items	Pre-conditions	Remark
1	Cross Section	Considered future widening to 6 lanes	Refer to 2.2.1
2	Bridge Length (Abutment Locations)	Between both sides of existing river bank protection	Refer to 2.2.2
3	Pier Shape and Locations	Shape	Round-shape piers
4		Locations	Not required taking into account the location of existing railway bridge
5	Navigational Clearance	Nos. and Locations	Secured whole spans
6		Clearance	6m*40m (6m*60m in consideration of 45 Degree of Skew)
7		Design High Water Level	H5% = 8.02m
8	Span Arrangement	Span Length	70m to 130m
9		Superstructure Type	PC Continuous Box Girder
10	Abutment	Abutment	Inverted T-shape abutment, Hmax=12m
11		Embankment Height	Hmax=14m
12	Foundation	Bore piles, Dia. 1.5m, L=40m	Refer to 2.2.7
13	Others	Design High Water Level	H1% = 8.66m
14		Freeboard	H = 1.0m (with drift wood)

#### 3.2 Preliminary Study

##### 3.2.1 Cross Section

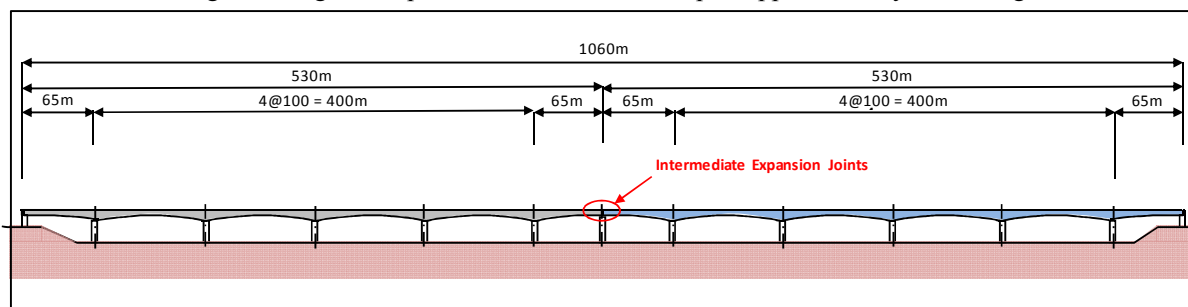
The cross section of Ky Lam Bridge is proposed to be complete 6-lanes from the initial stage of the Project in accordance with the proposals in 2.2.1 as shown in Figure 11.



**Figure 11 Crosse Section of Ky Lam Bridge**

##### 3.2.2 Girder Length

The superstructure was planned to be the continuous girder for whole bridge section; otherwise the navigational clearance could not be secured by the piers at intermediate expansion joints as shown in Figure 12. Therefore, the girder length was planned to be continued up to approximately 1 km long.



**Figure 12 Image of Piers at Intermediate Expansion Joints**

### 3.2.3 Support Conditions

Three types of support conditions that are 1) dispersion rubber bearings, 2) multiple anchorages and 3) rigid frames were compared as shown in Figure 13. Based on overseas experiences, the dispersion rubber bearings would be preferable for this type of the bridge; however, further study will be conducted and reported as a part of Basic Design Report (Civil, PKG3A).

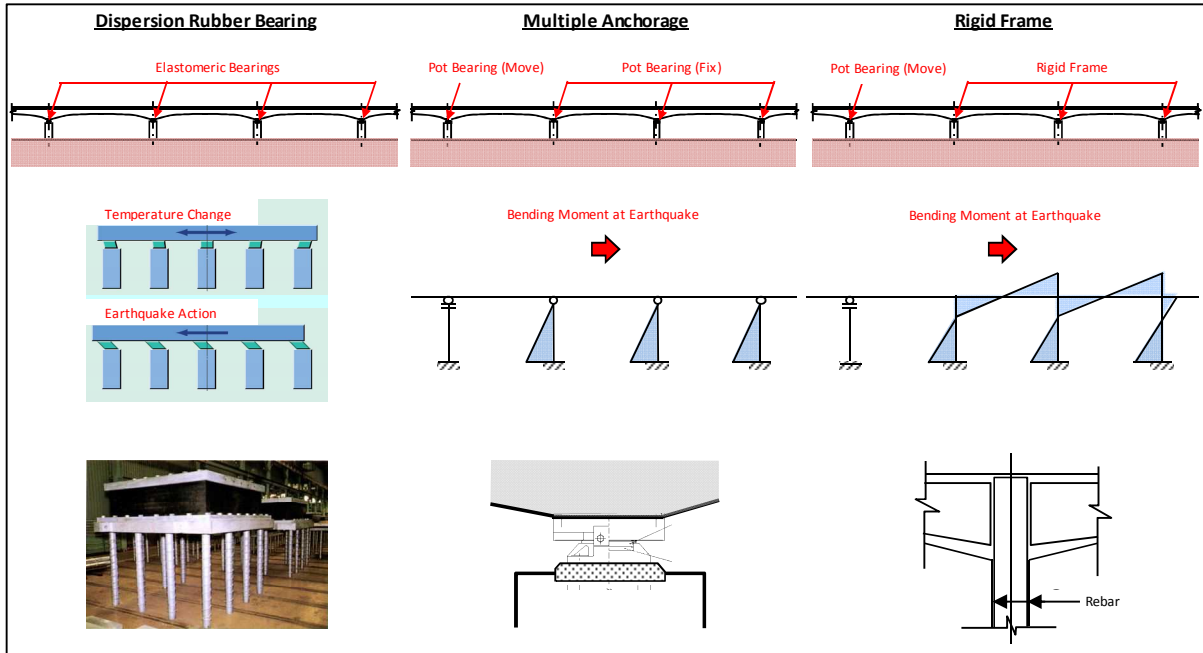


Figure 13 Image of Support Conditions

### 3.2.4 Round-shape Pier

The round shape pier with single column was proposed in the WB F/S Updating Study in 2009. This proposal was not adopted in the F/S-2010 to avoid the unstable loading conditions during the erection of the first of the two separated PC box girder.

Therefore, the round shape pier with separated pier column for each superstructure was proposed as shown in Figure 14.

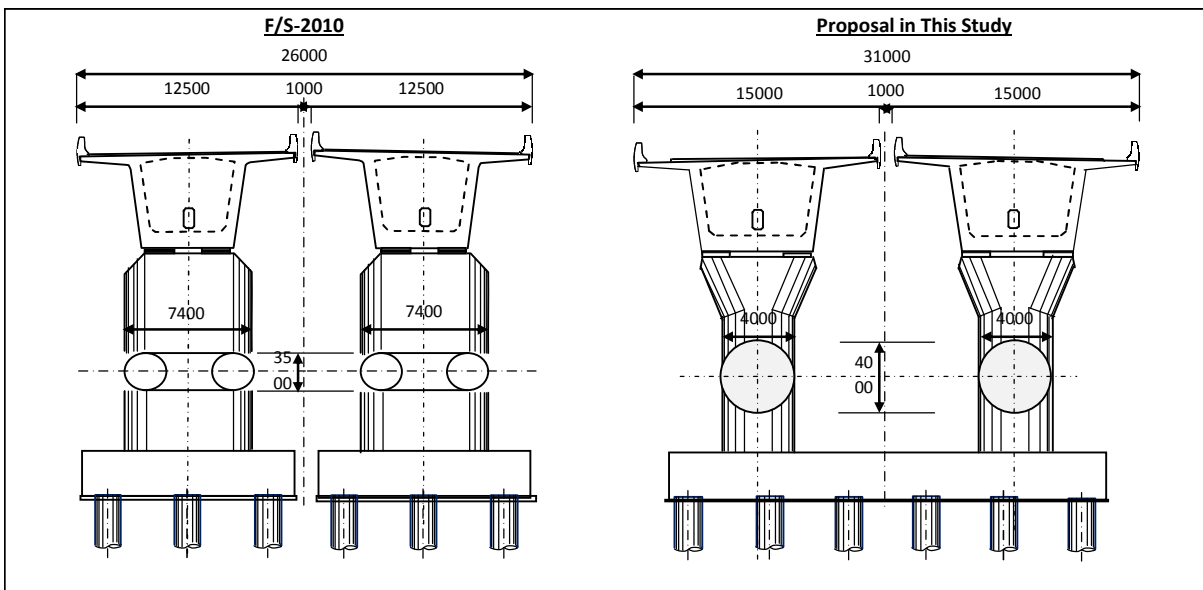


Figure 14 Proposed Round Shape Pier

### 3.2.5 Pier Locations

The riverbed scoring near the right bank was recognized by the topographic survey results as shown in Figure 15; this can be an evidence for the change of the river course in the past. In this regard, the pier locations were examined in 3.3.

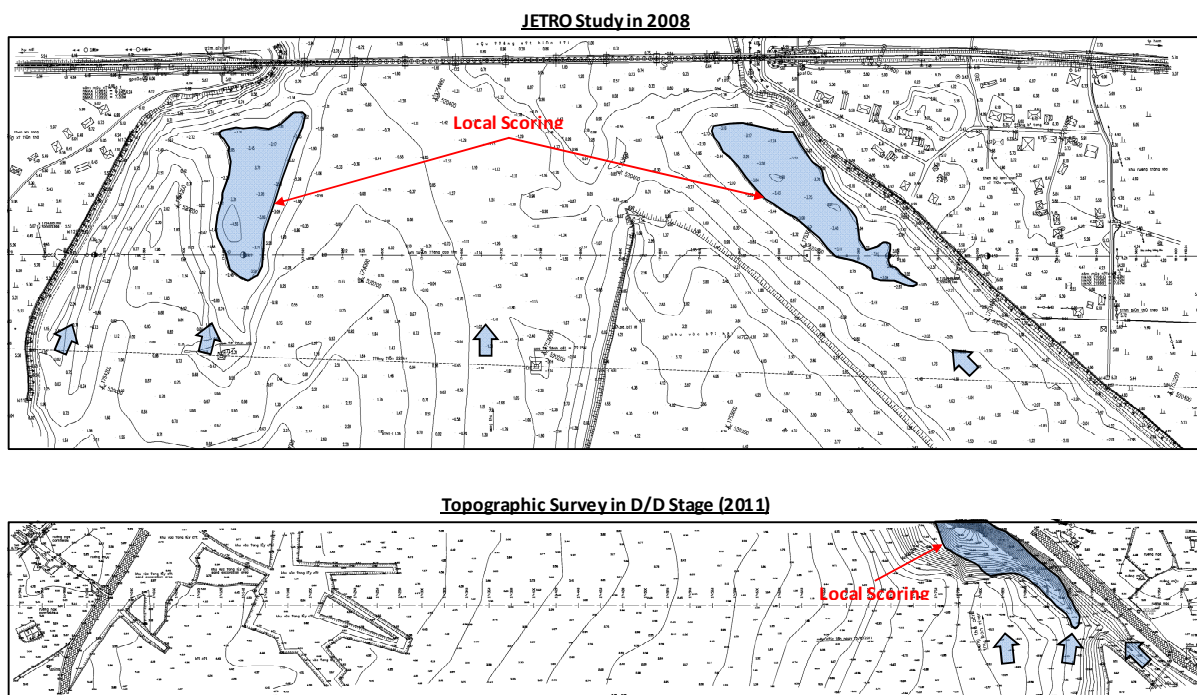


Figure 15 Local Scoring of Riverbed at near Right Bank Side

### 3.3 Alternative Bridge Plan

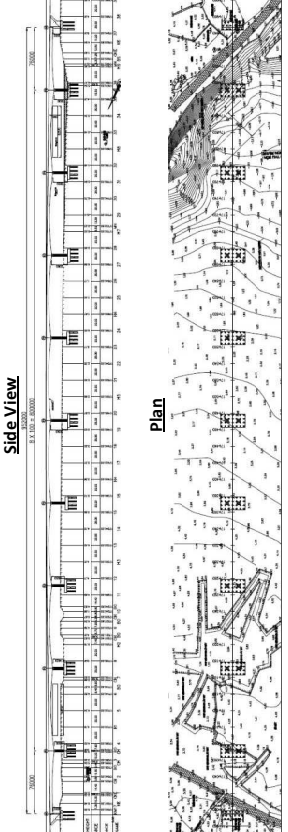
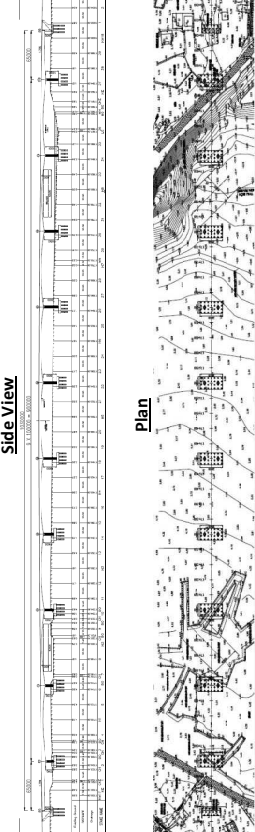
The two alternative bridge plans were established in this study and evaluated based on the requirements in 3.1 and 3.2.

The summary of the alternative bridge plans is shown in Table 9, and the evaluation is shown in Table 10 in the next page, respectively.

Table 9 Summary of Alternative Bridge Plan

No.	Items	Alternative 1	Alternative 2	Remark
1	Pier Locations	Allowed at near right bank	Not allowed near right bank	Refer to 3.2.5
2	Bridge Length	952m (Girder Length)	1030m (Girder Length)	
3	Superstructure	PC Continuous Box Girder	PC Continuous Box Girder	
4	Span Arrangement	76m+8@100 m+76m	65m+9@100m+65m	

**Table 10 Alternative Study Results**

Outline	Main Features	Construction		Comparison of the Construction Cost (F/S=1.00)	Evaluation
		Constructability	Period		
<p><b>Alternative 1: 10 Spans Continuous PC Box Girder</b> (Allowed Pier Locations at near Right Bank) (Girder Length =952 m, 76m+8@100m+76m)</p> 	<ul style="list-style-type: none"> <li>- Both abutments are planned on the existing bank protection to minimize the bridge length.</li> <li>- Span arrangement is 8@100m for whole section to secure the navigational clearance.</li> <li>- Profile is planned to limit abutment heights less than 12m.</li> <li>- P9 pier is planned near right side bank at the deepest location of the riverbed; therefore, local scoring at the pier is concerned.</li> <li>- Box culvert on approach road to A2 abutment is required to secure local transportation between upstream and downstream sides.</li> </ul>	<ul style="list-style-type: none"> <li>- Cantilever method is popular in Vietnam; constructability is technically no problem.</li> <li>- Supports for constructing side spans are long and on the slope of existing bank protections; careful safety management during the construction are required.</li> <li>- P9 Pier is located on the deepest location of river bed; then, temporary bridge and large scale of cofferdam in river are required.</li> </ul>	42 months	W=31.0m: 1.50 (W=26.0m: 1.23)	Not Selected
<p><b>Alternative 2: 11 Spans Continuous PC Box Girder</b> (Not allowed Pier Locations at near Right Bank) (Girder Length = 1030m, 65m+9@100 m+65m)</p> 	<ul style="list-style-type: none"> <li>- Both abutments are planned on the existing bank protection and secure one span margin on land of A2 abutment side for flood discharge and local transportation between upstream and downstream sides.</li> <li>- Span arrangement is planned 9@100m for whole section to secure the navigational clearance.</li> <li>- Profile is planned that abutment heights are less than 12m.</li> <li>- P9 pier is planned to avoid near right side bank at the deepest location of riverbed.</li> </ul>	<ul style="list-style-type: none"> <li>- Cantilever method is popular in Vietnam; constructability is technically no problem.</li> <li>- However, 1030m length of continuous girder will be the longest in Vietnam. The construction sequence and camber control are required to examine carefully.</li> </ul>	42 months	W=31.0m: 1.61 (W=26.0m: 1.33)	Selected

### 3.4 Selection of Optimum Bridge Plan

Based on the alternative study results, Alternative 2 in 3.3 was selected as the optimum bridge plan for Ky Lam Bridge by the following reasons:

- P9 Pier and A2 Abutment in Alternative 1 are located near the right bank; therefore, stream of flood discharge will be concentrated near at P9 Pier and A2 Abutment. On the other hand, Alternative 2 is securing one marginal span on land at A2 Abutment side; therefore, those risks are reduced (see Figure 16).
- P9 Pier in Alternative 1 is located near right side bank at the deepest location of riverbed; therefore, temporary bridge and large scale of cofferdam in the river are required.
- Support for constructing side spans in Alternative 1 is long and on the slope of existing bank protections; therefore, careful safety management during construction are required.
- Alternative 1 cannot secure a local transportation to cross the expressway at the right bank side. On the other hand, Alternative 2 can secure a crossing by one marginal span near A2 Abutment.

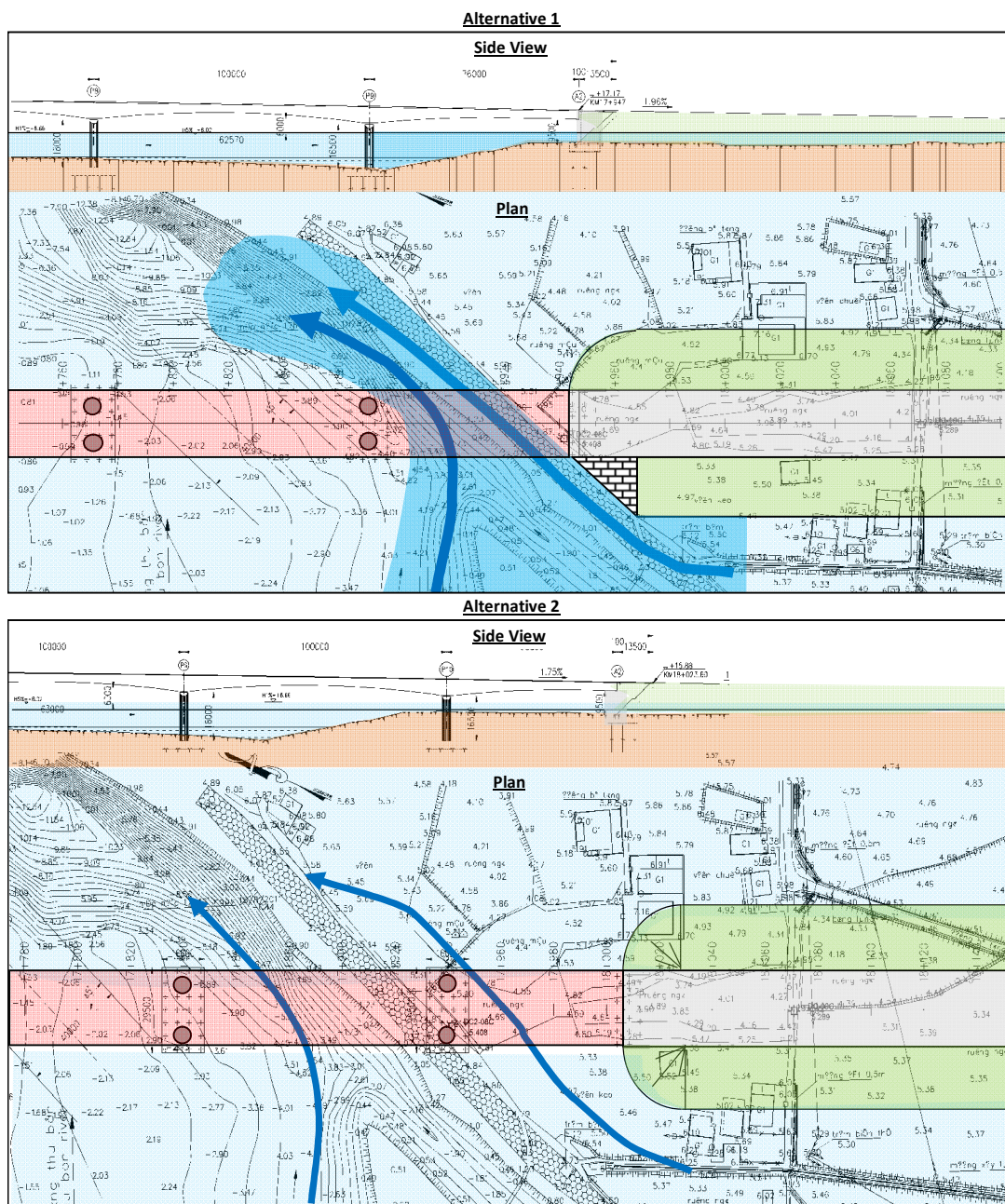


Figure 16 Stream of Flood Discharge in Alternative 1 and 2

#### 4 Conclusions

A summary of the alternative plan of Ky Lam Bridge proposed by the Consultant is shown in Table 11 as a conclusion of this study.

**Table 11 Summary of Alternative Bridge Plan of Ky Lam Bridge**

No.	Items	F/S (Original Plan)	Alternative (Proposed Plan)
1	Station (Bridge Section)	KM017+662	KM017+492
2	Bridge Length	950m (Girder Length)	1,030m (Girder Length)
3	Bridge Width	26m (Initial Stage: 4 lanes)	31m (Initial Stage: Complete 6 lanes)
4	Span Arrangement	4@40m+65m+5@100m+65m+4@40m	65m+9@100m+65m
5	Superstructure Type	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder	PC Box Girder
6	Navigational Clearance	6m*40m (6m*75m in consideration of 30 degree of skew)	6m*40m (6m*60m in consideration of 45 Degree of Skew)
7	Pier Shape	Wall type	Circular type

This alternative bridge plan will be finalized in accordance with the fundamental conditions which will be determined in the relevant study reports listed in Table 1 and will be submitted as a part of the Report No. 23)a) Basic Design Report (Civil, PKG3A).

## 5 Additional Alternatives based on the Comments on the Revision 1 of the Alternative Study Report for Ky Lam Bridge

The Consultants received several comments on the Revision 1 of the Alternative Study Report for Ky Lam Bridge from Vietnam Expressway Corporation (VEC) during the meeting held in Hanoi on December 27, 2011. This section 5 is additionally provided for this Revision 2 of the report.

### 5.1 Summary of the Instruction from VEC

Major instructions and comments on the Revision 1 of the report made by VEC are summarized as follows:

- The width of the bridge shall be 26m as planned in the F/S.
- Locations of the both abutments recommended by the Consultants are agreeable.
- A cylindrical pier shape recommended by the Consultants is agreeable.
- The span arrangement of the superstructure should be same as in the F/S to avoid the cost increase, however, the main spans (100m with PC box girder) can be shifted to accommodate the actual river channel on the right bank side. In this regard, the navigational clearance is sufficient to be secured at a span on the actual river channel.

### 5.2 Additional Alternatives based on the Comments from VEC

The additional alternative plans namely alternatives 3A and 3B were prepared based on the comments from VEC. Difference of the alternatives 3A and 3B is a type of the approach spans that are Super-T and PC-I respectively. Both alternatives consist of seven spans of PC box girder on the right side (Quang Ngai side) where the actual channel exists, and ten approach spans on the left side. Bridge features and a general view of the alternatives 3A and 3B are shown in Table 12, and Figures 17 and 18 respectively:

**Table 12 Summary of Alternatives 3A and 3B**

No.	Items	F/S (Original Plan)	Alternative 2 (Recommended in Rev. 1)	Alternative 3A	Alternative 3B
1	Station (Bridge Section)	KM017+662	KM017+492	KM017+500	
2	Bridge Length	950m (Girder Length)	1,030m (Girder Length)		
3	Bridge Width	26m (Initial Stage: 4 lanes)	31m (Initial Stage: Complete 6 lanes)	26m (Initial Stage: 4 lanes)	
4	Span Arrangement	4@40m+65m+5@100m+65m+4@40m	65m+9@100m+65m	10@40m+65m+5@100m+65m	
5	Superstructure Type	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder	PC Box Girder	Main Span: PC Box Girder, Approach Span: PC Super Tee Girder	Main Span: PC Box Girder, Approach Span: PC-I Girder
6	Navigational Clearance	6m x 40m* (6m x 75m in consideration of 30 degree of skew)	6m x 40m* (6m x 60m in consideration of 45 degree of skew)	6m x 30m** (6m x 50m in consideration of 45 degree of skew)	
7	Pier Shape	Wall type	Circular type		
	Remarks			A cut out at the end of Super Tee girders are not adopted	PC I girders will be connected longitudinally on the piers to be a continuous girder after the erection of the girders.

Note: \* applying TCVN 5664-1992, \*\* applying TCVN 5664-2009

It is noted that the type of the girder for approach section of Ky Lam Bridge is not specified in MOT's decision No.2656/QD-BGTVT dated September 10, 2010 regarding the approval of the F/S.

The elevations of the footings of the piers for 40m span sections are planned to be 2m beneath the existing ground level in the plans as a general manner. These elevations of the footings allow piles to be exposed to the water/air about 5m in maximum length according to the topographic map of the river in the previous study. Moreover, the exposure can be more than 13m if taking into account a scour of -12.54m in elevation observed at the right bank, approximately 70m downstream from the project centerline. Since exposed piles are not appropriate for the important arterial expressway in terms of seismic resistant and further local scour around the piles, it is necessary to evaluate the scour depth in detail and determine the optimum elevation of the footings considering the balance of a difficulty of excavation works, and negative impacts due to the exposure of the piles.

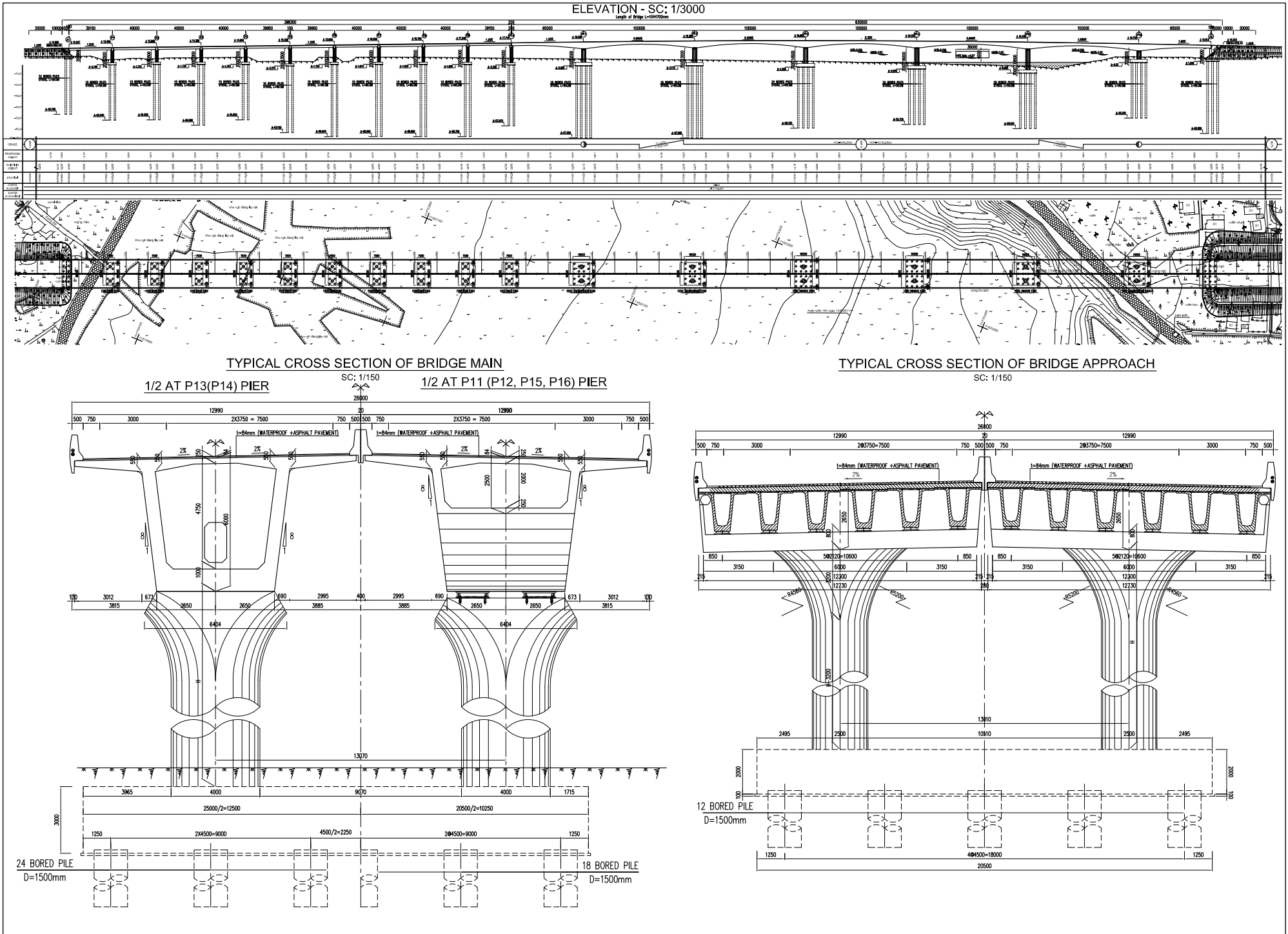


Figure 17 General View of the Alternative 3A  
A-1-28

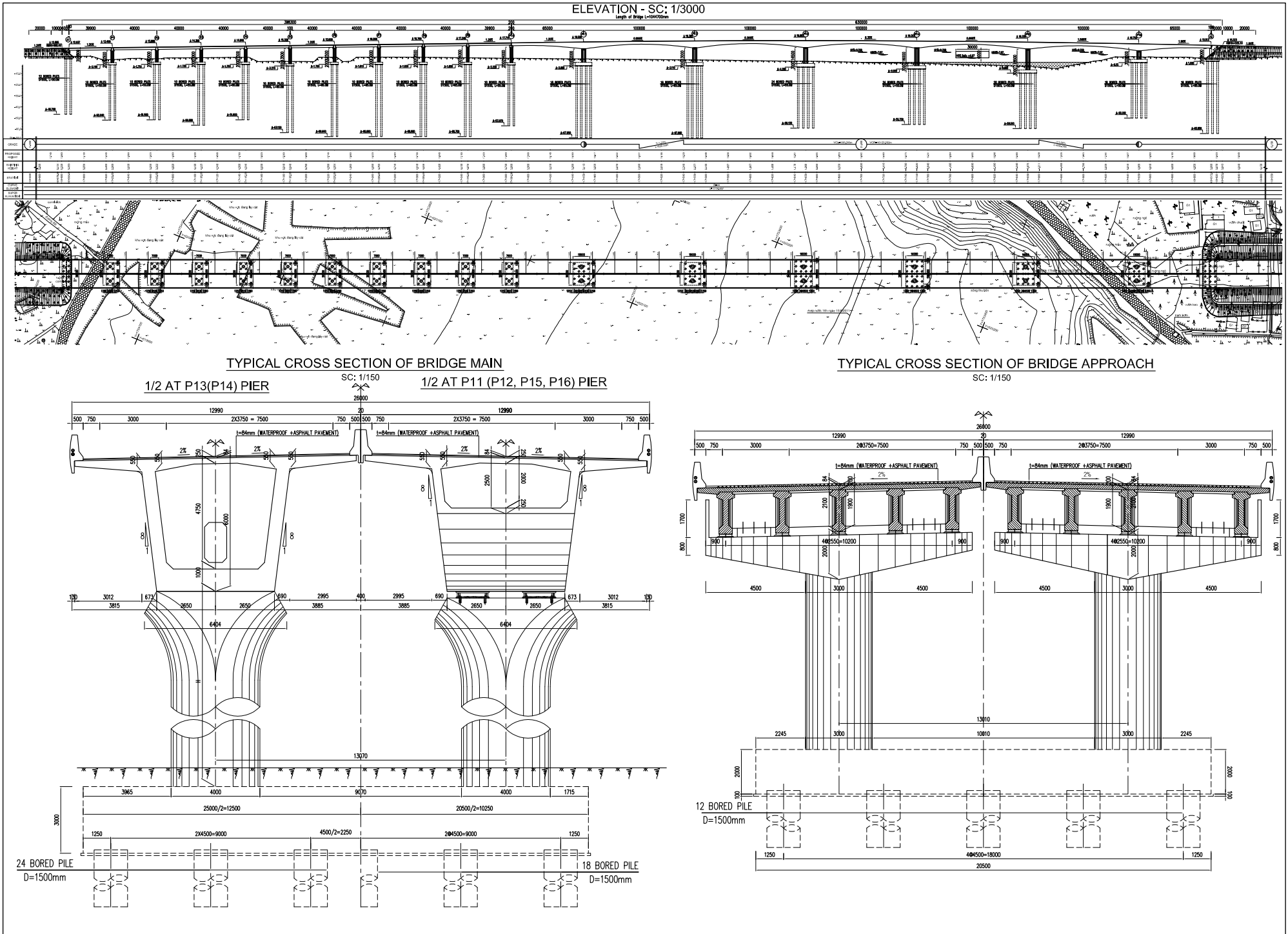


Figure 18 General View of the Alternative 3B  
A-1-29

### 5.3 Selection of the Optimum Alternative

The Consultants recommend the alternative with eleven spans PC box girder bridge as explained in the Section 4 of this report. However, due to a limitation of the budget, two more alternatives are provided as requested.

Between these two additional alternatives 3A and 3B, the Consultants recommend 3B with PC I-girder for following reasons:

- A PC I-girder has more examples and experiences world wide, especially for a high-grade arterial expressway which carries heavy trucks and high speed vehicles. Therefore, in terms of durability, it is more reliable in comparison with Super Tee which has history of less than 20 years.
- A cost of PC I-girder bridge is slightly less than Super Tee.

### 5.4 Comments on Span Arrangement and Navigational Clearance

For the arrangement of the span length, following issues are concerned:

- As mentioned in the Section 2.2.4, the sufficient navigational clearance may not be secured in the future due to the secular variation of the river channel. In this regard, it is strongly recommended that VEC explain this risk to DOT of Quang Nam Province and obtain their consent on this span arrangement.
- In general practice of river bridge planning in Japan, the standard span length of bridges over a river, which is generally referred to as the required minimum span length, is determined by the following empirical formula:

$$L_s = 20 + 0.005 Q$$

Where:  $L_s$  = standard span length in linear meter

$$Q = \text{peak discharge (m}^3/\text{sec)}$$

(Source: Government Ordinance for Structural Standard for River Administration Facilities, Japan)

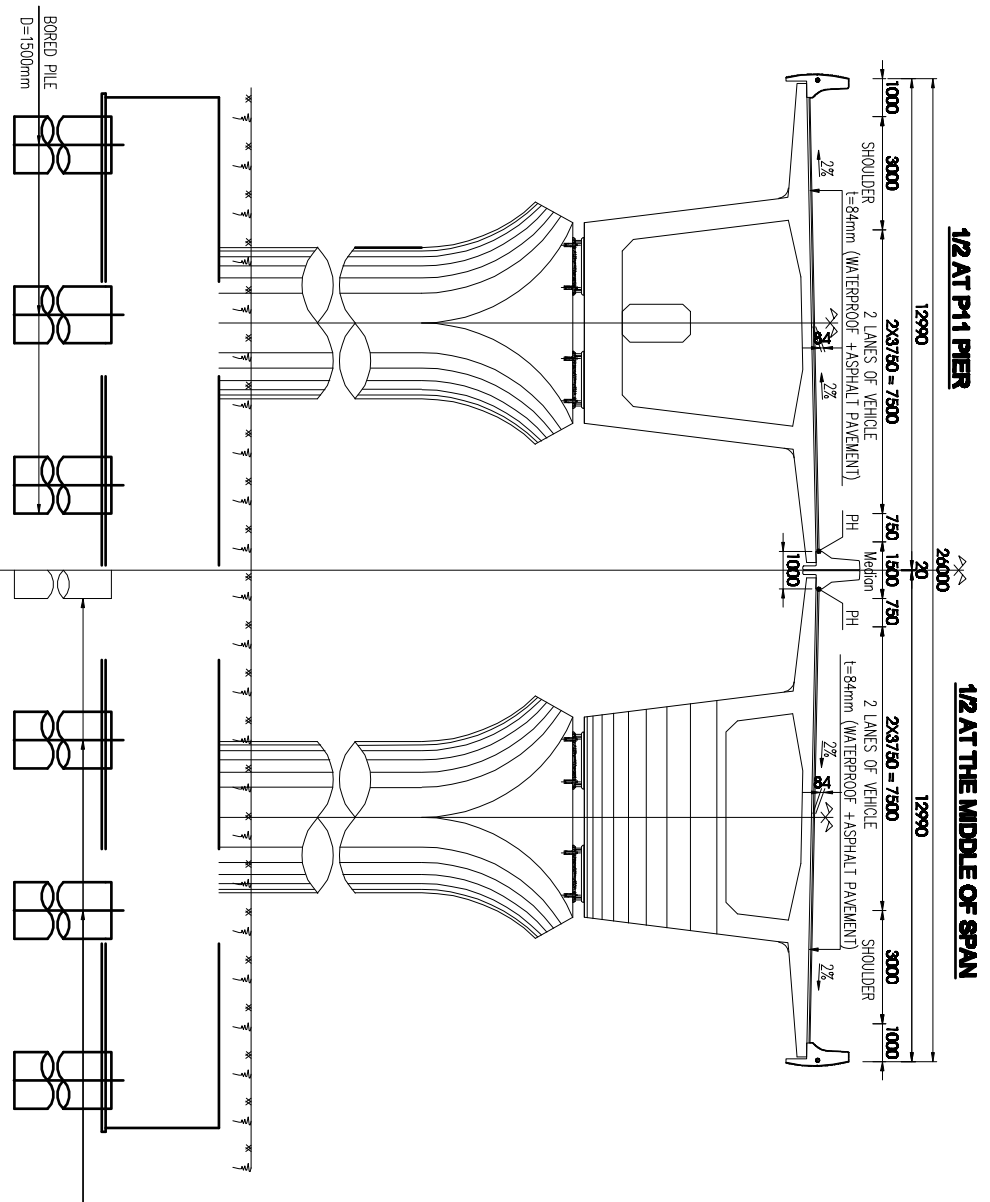
According to the on-going hydrological study, the 1% discharge for Ky Lam Bridge is roughly calculated as 15,000m<sup>3</sup>/sec. As a result, the standard span length is estimated as 95m applying the discharge to the above formula.

- The existing river bank protection especially on the right bank shall be relocated because the first pier and the protection are located too close each other due to a short span length.
- The increase of the number of piers from 10 (all PC box) to 16 (PC box and PC-I girders) will augment the difficulties of the foundation and excavation works (depending on the elevation of the footings below the ground level evaluated by scour analysis).

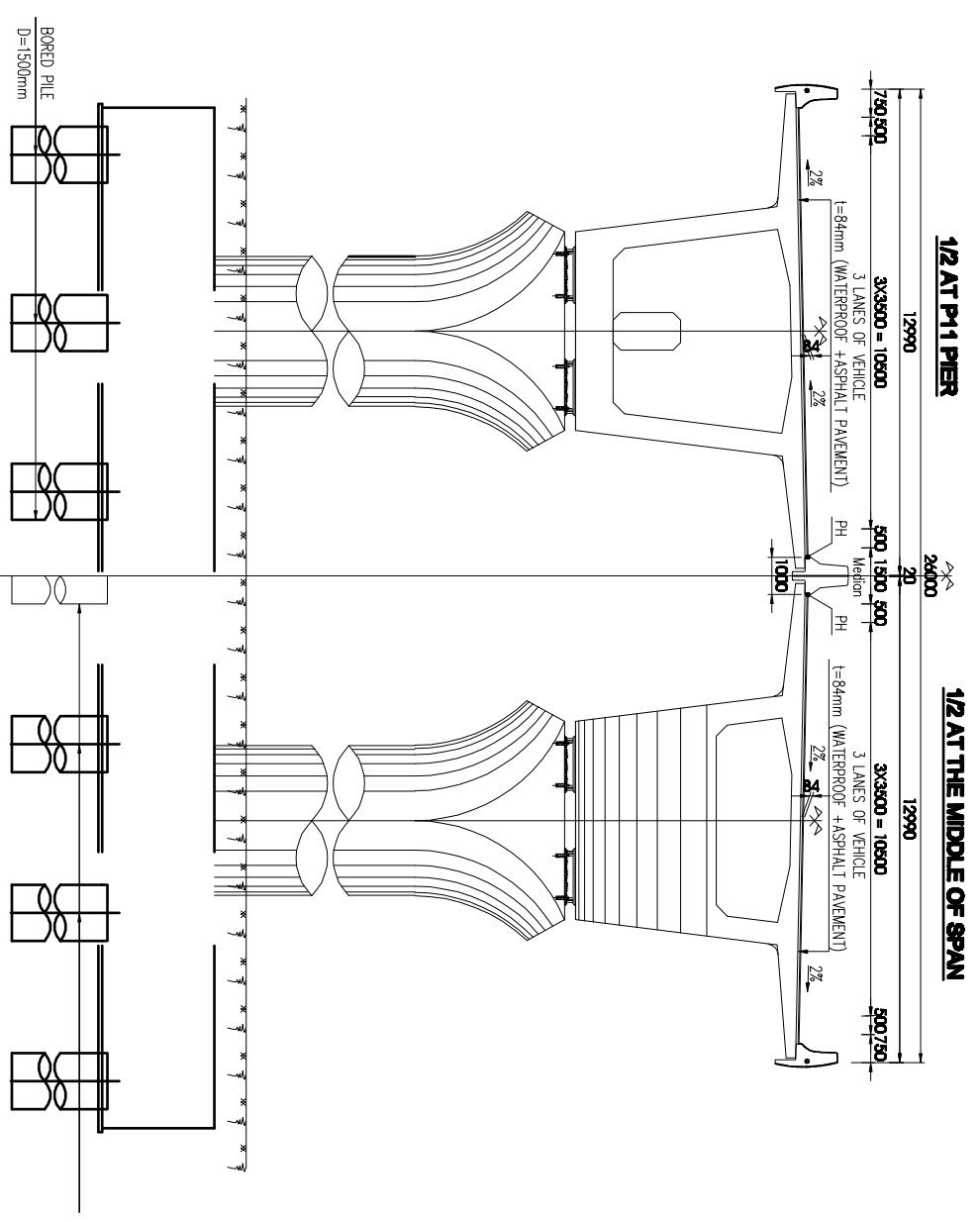
**Appendix 2 : Typical Cross Section (18 April 2012) (extracted from “Typical Cross Section Report”)**



TYPE M-09: PC-BOX GIRDER (INITIAL)



TYPE M-10: PC-BOX GIRDER (ULTIMATE)



NOTES: ALL DIMENSIONS ARE IN MILLIMETER UNLESS OTHERWISE INDICATED.

MINISTRY OF TRANSPORT VIETNAM

ENGINEERING DESIGN CONSULTANT

CLIENT	PROJECT MANAGEMENT CONSULTANT	The Joint Venture of Nguyen Kien Co., Ltd. Nguyen Engineering Consultants Co., Ltd. Credent Co., Ltd. Tnd Engineering Consultants Co., Ltd.
VIETNAM EXPRESSWAY CORPORATION	PROJECT MANAGEMENT UNIT NO.05	

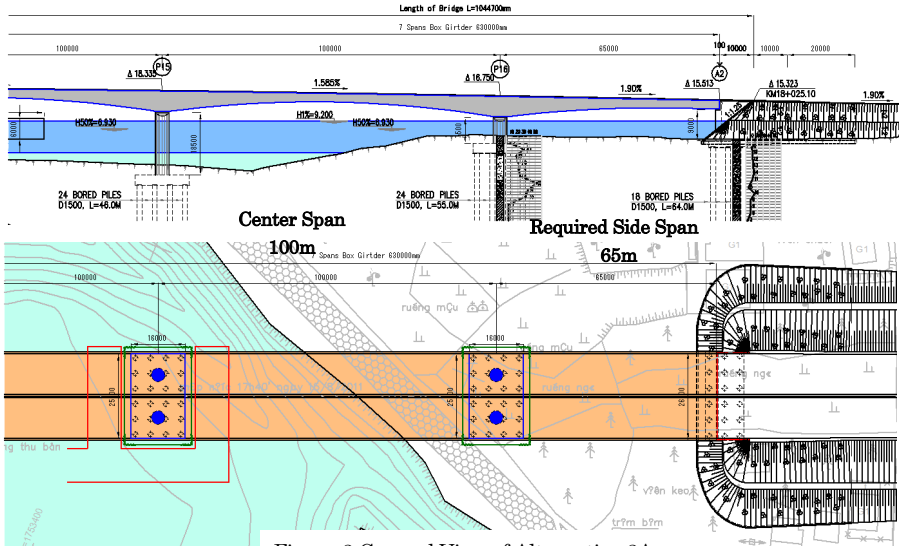
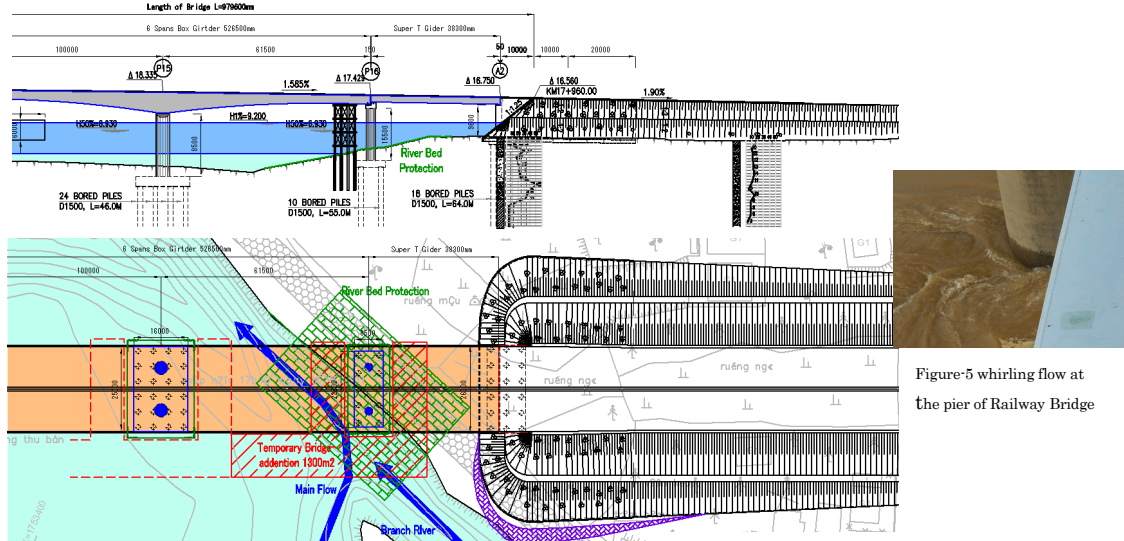
DA NANG-QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT

Package: 3A Station: Km10+000 - Km10+100

PREPARED BY	CHECKED BY	APPROVED BY	TYPICAL CROSS SECTION (TYPE M-09, M-10)
NAME	P.V. HUNG	T.QUANG	SCALE
SIGNATURE			1:200
DATE			DRAWING NO. PS4-001
			REV. NO.

**Appendix 3 : Comparison of Alternative 3A and PMU85's  
proposal of relocation of abutment and pier**

Table-1 Comparison table of Alternative 3A and PMU85 Proposal

General View	Main Features	Construction Cost (Alternative 3A=1.0)	Evaluation
<p><b>Alternative 3A</b> 10 Spans Super T+7Spans Box Girder (10@40+65+5@100+61.5+) Bridge Length=1044.7m</p>  <p>Figure-3 General View of Alternative 3A</p>	<p><b>Outline of Alternative 3A is as follows</b></p> <ul style="list-style-type: none"> <li>● Pier16 is planned to avoid near the right side bank protection at the deepest location of riverbed.</li> <li>● Abutment A2 is planned on the existing bank protection and secure one span margin on land of A2 abutment side for flood discharge and local transportation between upstream and downstream sides.</li> </ul>	<p>59 MIL USD (1.0)</p>	<p>Selected</p>
<p><b>PMU85 Proposal</b> 10 Spans Super T+6Spans Box Girder +Simple Super T (10@40+65+4@100+61.5+38.3) Bridge Length=979.6m</p>  <p>Figure-4 General View of PMU85 Proposal</p> <p>Figure-5 whirling flow at the pier of Railway Bridge</p>	<p><b>Outline of this proposal is as follows:</b></p> <ul style="list-style-type: none"> <li>● Shifting the A2 abutment toward P16 pier (called new A2 abutment) and shift P16 pier to the north about 40m (called new P16 pier)</li> <li>● The span from new P16 pier to new A2 abutment shall be constructed by super T-Girder with 40m length.</li> </ul> <p><b>-Review Comment-</b></p> <ul style="list-style-type: none"> <li>➢ The location of new P16 pier is on the edge of right side bank protection. This location is near the point where the river flow become extremely unstable and fast</li> <li>➢ It will cause to increase the local scour same as railway bridge pier shown in Figure-5</li> <li>➢ Cost of river revetment, bank protection and temporarily bridge will be increased more than Alternative 3A</li> <li>➢ Side span is located in the deepest location of river bed, so it is very difficult and costly to erect the support</li> <li>➢ There is concern that new p16 will become unstable condition in future due to the local scour</li> </ul>	<p>60 MIL USD (1.02)</p>	<p>Not Selected</p>

**Appendix 4 : Work Quantity and Construction Cost  
for the Package3A**



## BILL OF QUANTITIES Alternative 2

Detailed Design for Danang-Quang Ngai Expressway Development Project  
 IDA Credit No.3843-VN  
 PACKAGE 3A (Km16+880~Km18+100) : Ky Lam Bridge

BILL ITEM	DIVISION NO. PAY ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE		AMOUNT		AMOUNT COMBINED (in VND)
					FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	
<b>A</b>	<b>GENERAL</b>								
<b>A</b>	<b>DIVISION 01 GENERAL REQUIRMENTS</b>								
A	Section 01000	General Provisions							
A	Section 01050	General Works							
A	Section 01100	Contractor's Mobilization							
A	01100-01	Mobilization and Demobilization	LS	1					12,098,353,249
A	Section 01110	Temporary Works							
A	01110-01	Temporary Road	LS	1					53,916,446,000
A	01110-02	Temporary Site Compound	LS	1					3,240,000,000
A	01110-04	Temporary Bridge	LS	1					27,555,000,000
A	Section 01150	Contractor's Submittals							
A	01150-01	Contractor's Drawing							
A	01150-02	Programme of Work							
A	01150-03	Monthly Progress Reports							
A	01150-04	Construction Photographs and Video Recording							
A	Section 01200	Contractor's Drawings							
A	Section 01300	Programme of Work							
A	Section 01400	Monthly Progress Reports							
A	Section 01500	Project Safety							
A	01500-01	Project Safety							
A	Section 01600	Maintenance and Protection of Traffic							
A	01600-01	Maintenance and Protection of Traffic							
A	Section 01800	Contractor's Quality Control							
A	01800-01	Contractor's Quality Control							
A	Section 01850	Acceptance of Work							
A	Section 01900	Control of Materials							
<b>TOTAL BILL ITEM A (CARRY OVER TO BID PRICE SUMMARY)</b>							0	96,809,799,249	96,809,799,249

BILL ITEM	DIVISION NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE		AMOUNT		AMOUNT COMBINED (in VND)
					FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	
<b>B</b>	<b>EARTH WORKS</b>								
<b>B1</b>	<b>HIGHWAY WORKS</b>								
<b>B1-1</b>	<b>DIVISION 02 SITE WORKS</b>								
B1-1	Section 02100	Site Clearing							
B1-2	02100-01	Clearing and Grubbing	m2	68,200		21,000		1,432,200,000	1,432,200,000
B1-3	Section 02200	Demolition							
B1-4	02200-01	Demolition of Existing Concrete Structure	m3	200		940,000		188,000,000	188,000,000
	(Sub-Total B1-1)						0	1,620,200,000	1,620,200,000
<b>B1-2</b>	<b>DIVISION 03 EARTH WORKS</b>								
B1-2	Section 03100	Common Excavation							
B1-2	03100-01	Soil Excavation	m3			90,000		0	0
B1-2	03100-02	Unsuitable Material (Waste Excavation)	m3	5,812		75,000		435,900,000	435,900,000
B1-2	Section 03400	Embankment Construction							
B1-2	03400-01	Subgrade Construction by Borrow Material (K=98%)	m3	2,138		275,000		587,950,000	587,950,000
B1-2	03400-02	Below Subgrade Construction by Borrow Material (K=95%)	m3	83,421		270,000		22,523,670,000	22,523,670,000
B1-2	Section 03800	Aggregate Subbase and Base							
B1-2	03800-01	Aggregate Subbase	m3	1,710		350,000		598,500,000	598,500,000
B1-2	03800-02	Aggregate base	m3	1,710		360,000		615,600,000	615,600,000
	(Sub-Total B1-2)						0	24,761,620,000	24,761,620,000
<b>B1-3</b>	<b>DIVISION 04 DRAINAGE WORKS</b>								
B1-3									
B1-3		Bridge surface effluent treatment basin	each	2		50,000,000		100,000,000	100,000,000
	(Sub-Total B1-4)						0	100,000,000	100,000,000
<b>B1-4</b>	<b>DIVISION 05 PAVEMENT WORKS</b>								
B1-4	Section 05100	Prime coat							
B1-4	05210-01	Prime Coat	m2	4,304		30,000		129,120,000	129,120,000
B1-4	Section 05200	Tack Coat							
B1-4	05200-01	Tack Coat	m2	8,509		25,000		212,725,000	212,725,000
B1-4	Section 05300	Asphalt Concrete Binder and Surface Courses							
B1-4	05300-01	Anti skid AC surface 3cm	m2	4,244		155,000		657,820,000	657,820,000
B1-4	05300-02	AC fine course 5cm	m2	4,266		278,000		1,185,948,000	1,185,948,000
B1-4	05300-03	AC binder course 8cm	m2	4,304		360,000		1,549,440,000	1,549,440,000
	(Sub-Total B1-3)						0	3,735,053,000	3,735,053,000
<b>B1-5</b>	<b>DIVISION 08 ROAD FURNITURE AND MISCELLANEOUS</b>								
B1-5	Section 08100	Slope Protection							
B1-5	08100-01	Concrete Panel 50cm*50cm*5cm	m2	1,790		500,000		895,000,000	895,000,000
B1-5	08100-02	Cement Mortar Stone Pitching for Slope Protection	m2	670		3,500,000		2,345,000,000	2,345,000,000
B1-5	Section 08150	Sodding and Planting							
B1-5	08150-01	Sodding	m2	3,550		36,000		127,800,000	127,800,000
B1-5	Section 08200	Topsoiling							
B1-5	08200-01	Furnishing and Placing Topsoil	m2	3,550		3,000		10,650,000	10,650,000
B1-5	08200-02	Filling for Topsoiling	m3	355		250,000		88,750,000	88,750,000
B1-5	Section 08920	Concrete Curb							
B1-5	08920-01	Concrete Curb, 47x20x50cm	lm	377		590,000		222,430,000	222,430,000
	(Sub-Total B1-5)						0	3,689,630,000	3,689,630,000
	<b>TOTAL BILL ITEM B (CARRY OVER TO BID PRICE SUMMARY)</b>						0	33,906,503,000	33,906,503,000

BILL ITEM	DIVISION NO. PAY ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE		AMOUNT		AMOUNT COMBINED (in VND)
					FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	
<b>C</b>	<b>BRIDGE WORKS</b>								
<b>C1</b>	<b>SUPERSTRUCTURE</b>								
C1-1	Section 05200	Tack Coat							
C1-1	05200-01	Tack Coat	m2	24,720		17,000		420,240,000	420,240,000
C1-1	Section 05300	Asphalt Concrete Binder and Surface Courses							
C1-1	05300-03	Normal A/C Surface Course, thickness=8cm (for Bridge)	m2	24,720		320,000		7,910,400,000	7,910,400,000
	(Sub-Total C1-1)							0	8,330,640,000
<b>C1-2</b>	<b>DIVISION 06 CONCRETE</b>								
C1-2	Section 06100	Concrete and Concrete Structures							
C1-2	06100-05	Class A2 Concrete (45Mpa) for Box girder	m3	14,237		14,000,000		199,318,000,000	199,318,000,000
		Class C Concrete (35Mpa) for Super-T cross beam	m3	61		7,000,000		428,400,000	428,400,000
		Class D Concrete (30Mpa) for Super-T deck concrete	m3	2,000		5,000,000		10,000,000,000	10,000,000,000
C1-2	06100-08	Class E Concrete (25Mpa) for concrete barrier	m3	2,202		3,090,000		6,804,180,000	6,804,180,000
		Super-T girder (L=38.30m)	each	120		650,000,000		78,000,000,000	78,000,000,000
C1-2	Section 06220	Prestressed Concrete							
C1-2	06220-03	Internal Prestressing Tendons - Type 19S15.2	ton	599		172,000,000		103,028,000,000	103,028,000,000
C1-2	06220-04	Internal Prestressing Tendons - Type 3T15.2	ton	70		232,000,000		16,332,800,000	16,332,800,000
		PC Bar for Vertical (ø32mm)	ton	28		160,000,000		4,480,000,000	4,480,000,000
C1-2	Section 06400	Reinforcing Steel							
C1-2	06400-01	Reinforcing Steel - Deformed Bars (D ≤ 10mm)	ton	0		26,800,000		0	0
C1-2	06400-02	Reinforcing Steel - Deformed Bars (D ≤ 18mm)	ton	1,991		27,000,000		53,770,392,000	53,770,392,000
C1-2	06400-03	Reinforcing Steel - Deformed Bars (18mm<D)	ton	663		27,100,000		17,967,950,400	17,967,950,400
C1-2	Section 06800	Bridge Bearings							
C1-2	06800-03	Bearing elastomeric type A1 (3000kN)	each	8		100,000,000		800,000,000	800,000,000
C1-2	06800-04	Bearing elastomeric type A2 (16000kN)	each	12		750,000,000		9,000,000,000	9,000,000,000
		Bearing elastomeric type A3 te=83mm	each	240		20,000,000		4,800,000,000	4,800,000,000
C1-2	Section 06900	Deck Waterproofing							
C1-2	06900-01	Deck Waterproofing Membrane	m2	24,720		130,000		3,213,600,000	3,213,600,000
C1-2	Section 06910	Expansion Joint							
C1-2	06910-01	Expansion Joint Type A (Δ250)	lm	96		210,000,000		20,160,000,000	20,160,000,000
	(Sub-Total C1-2)							0	528,103,322,400
<b>C1-3</b>	<b>DIVISION 07 STEEL WORKS</b>								
C1-3	Section 07210	Bridge Rails and name plaques							
C1-3	07210-01	Bridge Name Plaques	each	2		720,000		1,440,000	1,440,000
		Bridge History Plaques	each	1		720,000		720,000	720,000
C1-3	Section 07400	Bridge Drainage							
C1-3	07400-01	Bridge Drainage, Type 1	set	206		1,900,000		391,400,000	391,400,000
C1-3	07400-03	Bridge Drain PVC Pipe D300mm	lm	2,060		653,000		1,345,180,000	1,345,180,000
	(Sub-Total C1-3)							0	1,738,740,000
	<b>TOTAL BILL ITEM C1 (CARRY OVER TO BID PRICE SUMMARY)</b>							0	538,172,702,400

BILL ITEM	DIVISION NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE		AMOUNT		AMOUNT COMBINED (in VND)
					FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	FOREIGN CURRENCY (USD)	LOCAL CURRENCY (VND)	
C2	<b>SUBSTRUCTURE</b>								
C2-1	<b>DIVISION 03 EARTH WORKS</b>								
C2-1	Section 03200	Structure Excavation							
C2-1	03200-01	Structural Excavation - type A (Open excavation)	m3	280		80,000		22,400,000	22,400,000
	03200-02	Structural Excavation - type B (Used steel sheet pile)	m3	27,143		1,600,000		43,428,800,000	43,428,800,000
	03200-03	Structural Excavation - type C (Used cofferdam )(under	m3	2,835		1,600,000		4,536,000,000	4,536,000,000
C2-1	03200-04	Blinding Stone	m3	0		950,000		0	0
C2-1	03200-05	Granular Backfill (Compaction 95%)	m3	17,066		376,000		6,416,816,000	6,416,816,000
	(Sub-Total C2-1)						0	54,404,016,000	54,404,016,000
C2-2	<b>DIVISION 06 CONCRETE</b>								
C2-2	Section 06100	Concrete and Concrete Structures							
C2-2	06100-05	Class D Concrete (30Mpa)	m3	18,259		3,500,000		63,906,500,000	63,906,500,000
	06100-09	Class E Concrete (25Mpa)	m3	72		2,500,000		180,000,000	180,000,000
C2-2	06100-09	Class G Concrete (10Mpa)	m3	475		1,500,000		712,500,000	712,500,000
C2-2	Section 06210	Cast-in-Place Pile							
C2-2	06210-01	Cast-in-place Concrete Pile, dia. 1500mm	lm	7,800		28,000,000		218,400,000,000	218,400,000,000
	06210-02	Cast-in-place Concrete Pile, dia. 1000mm	lm	14,565		16,000,000		233,040,000,000	233,040,000,000
C2-2	06210-03	Pile's Core Test	Nos.	420		4,800,000		2,016,000,000	2,016,000,000
C2-2	06210-04	Pile's Integrity Sonic Test	each	1,260		1,100,000		1,386,000,000	1,386,000,000
C2-2	06210-05	PDA Test for Cast-in-place Concrete Pile, dia. 1500mm	Nos.	2		55,000,000		110,000,000	110,000,000
		PDA Test for Cast-in-place Concrete Pile, dia. 1000mm	Nos.	2		40,000,000		80,000,000	80,000,000
C2-2	Section 06400	Reinforcing Steel							
C2-2	06400-02	Reinforcing Steel - Deformed Bars (D ≤ 18mm)	ton	1,880		27,000,000		50,765,918,400	50,765,918,400
C2-2	06400-03	Reinforcing Steel - Deformed Bars (18mm < D)	ton	470		27,100,000		12,738,485,080	12,738,485,080
C2-2	Section 06800	Bridge Bearings							
C2-2	06800-08	Plane Elastomeric Pad 150*150*20	m2	1		16,700,000		16,700,000	16,700,000
	(Sub-Total C2-2)						0	583,352,103,480	583,352,103,480
	<b>TOTAL BILL ITEM C2 (CARRY OVER TO BID PRICE SUMMARY)</b>						0	637,756,119,480	637,756,119,480

# COMPARISON TABLE OF CONSTRUCTION COST BETWEEN BD and FS

Detailed Design for Danang-Quang Ngai Expressway Development Project

IDA Credit No.3843-VN

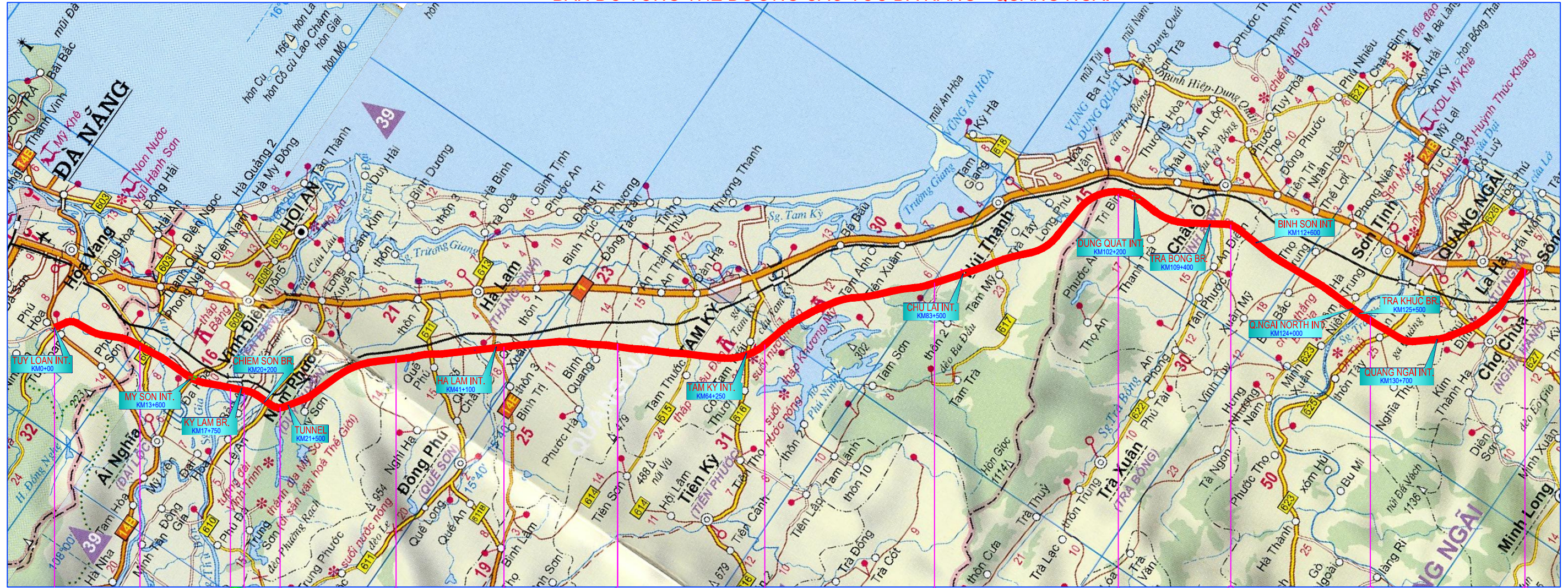
PACKAGE 3A (Km16+880~Km18+100) : Ky Lam Bridge

BILL ITEM	DIVISION NO.	ITEM DESCRIPTION	UNIT	BASIC DESIGN				BD Cost by FS Unit Price (B)	FS				Balance (D)-(A)-(C)	Quantity Change (E)=(B)-(C)	Lack of Item and Quantity	Change of Unit Price	Total
				QUANTITY	UNIT PRICE	AMOUNT	AMOUNT COMBINED (A)		QUANTITY	UNIT PRICE	AMOUNT	AMOUNT COMBINED (C)					
					LOCAL CURRENCY (VND)	LOCAL CURRENCY (VND)				LOCAL CURRENCY (VND)	LOCAL CURRENCY (VND)						
<b>A</b>	<b>GENERAL</b>																
<b>A</b>	<b>DIVISION 01 GENERAL REQUIRMENTS</b>																
A	Section 01000	General Provisions															
A	Section 01050	General Works															
A	Section 01100	Contractor's Mobilization															
A	01100-01	Mobilization and Demobilization	LS	1		12,098,353,249	12,098,353,249					0	12,098,353,249		12,098,353,249		12,098,353,249
A	Section 01110	Temporary Works															
A	01110-01	Temporary Road	LS	1		53,916,446,000	53,916,446,000					0	53,916,446,000		53,916,446,000		53,916,446,000
A	01110-02	Temporary Site Compound	LS	1		3,240,000,000	3,240,000,000					0	3,240,000,000		3,240,000,000		3,240,000,000
A	01110-04	Temporary Bridge	LS	1		27,555,000,000	27,555,000,000					0	27,555,000,000		27,555,000,000		27,555,000,000
A	Section 01150	Contractor's Submittals															
A	01150-01	Contractor's Drawing															
A	01150-02	Programme of Work															
A	01150-03	Monthly Progress Reports															
A	01150-04	Construction Photographs and Video Recording															
A	Section 01200	Contractor's Drawings															
A	Section 01300	Programme of Work															
A	Section 01400	Monthly Progress Reports															
A	Section 01500	Project Safety															
A	01500-01	Project Safety															
A	Section 01600	Maintenance and Protection of Traffic															
A	01600-01	Maintenance and Protection of Traffic															
A	Section 01800	Contractor's Quality Control															
A	01800-01	Contractor's Quality Control															
A	Section 01850	Acceptance of Work															
A	Section 01900	Control of Materials															
		<b>TOTAL BILL ITEM A (CARRY OVER TO BID PRICE SUMMARY)</b>				96,809,799,249	96,809,799,249	0				0	96,809,799,249	0	96,809,799,249	0	96,809,799,249
<b>B</b>	<b>EARTH WORKS</b>																
<b>B1</b>	<b>HIGHWAY WORKS</b>																
<b>B1-1</b>	<b>DIVISION 02 SITE WORKS</b>																
B1-1	Section 02100	Site Clearing															
B1-2	02100-01	Clearing and Grubbing	m2	68,200	21,000	1,432,200,000	1,432,200,000	94,798,000		1,390	0	0	1,432,200,000	94,798,000		1,337,402,000	1,432,200,000
B1-3	Section 02200	Demolition						0									
B1-4	02200-01	Demolition of Existing Concrete Structure	m3	200	940,000	188,000,000	188,000,000	0				0	188,000,000	0	188,000,000		188,000,000
		(Sub-Total B1-1)				1,620,200,000	1,620,200,000	94,798,000				0	1,620,200,000	94,798,000	188,000,000	1,337,402,000	1,620,200,000
<b>B1-2</b>	<b>DIVISION 03 EARTH WORKS</b>																
B1-2	Section 03100	Common Excavation															
B1-2	03100-01	Soil Excavation	m3		90,000	0	0	0		262	149,000	38,963,500	38,963,500	(38,963,500)	(38,963,500)	0	(38,963,500)
B1-2	03100-02	Unsuitable Material (Waste Excavation)	m3	5,812	75,000	435,900,000	435,900,000	376,327,000			64,750	0	435,900,000	376,327,000	59,573,000		435,900,000
B1-2	Section 03400	Embankment Construction															
B1-2	03400-01	Subgrade Construction by Borrow Material (K=98%)	m3	2,138	275,000	587,950,000	587,950,000	214,869,000			100,500	0	587,950,000	214,869,000		373,081,000	587,950,000
B1-2	03400-02	Below Subgrade Construction by Borrow Material (K=95%)	m3	83,421	270,000	22,523,670,000	22,523,670,000	9,843,678,000		62,000	118,000	7,316,000,000	7,316,000,000	15,207,670,000	2,527,678,000	12,679,992,000	15,207,670,000
		Graded filter	m3			0	0	0		47	413,000	19,328,400	19,328,400	(19,328,400)	(19,328,400)	0	(19,328,400)
B1-2	Section 03800	Aggregate Subbase and Base															
B1-2	03800-01	Aggregate Subbase	m3	1,710	350,000	598,500,000	598,500,000	552,330,000			323,000	0	598,500,000	552,330,000		46,170,000	598,500,000
B1-2	03800-02	Aggregate base	m3	1,710	360,000	615,600,000	615,600,000	588,240,000			344,000	0	615,600,000	588,240,000	27,360,000		615,600,000
		(Sub-Total B1-2)				24,761,620,000	24,761,620,000	11,575,444,000			7,374,291,900	7,374,291,900	17,387,328,100	4,201,152,100	0	13,186,176,000	17,387,328,100
<b>B1-3</b>	<b>DIVISION 04 DRAINAGE WORKS</b>																
B1-3																	
B1-3		Bridge surface effluent treatment basin	each	2	50,000,000	100,000,000	100,000,000	0					100,000,000	0	100,000,000		100,000,000
		(Sub-Total B1-3)				100,000,000	100,000,000	0					100,000,000	0	100,000,000	0	100,000,000
<b>B1-4</b>	<b>DIVISION 05 PAVEMENT WORKS</b>																
B1-4	Section 05100	Prime coat															
B1-4	05210-01	Prime Coat	m2	4,304	30,000	129,120,000	129,120,000	142,032,000		6,000	33,000	198,000,000	198,000,000	(68,880,000)	(55,968,000)	(12,912,000)	(68,880,000)
B1-4	Section 05200	Tack Coat						0									
B1-4	05200-01	Tack Coat	m2	8,509	25,000	212,725,000	212,725,000	212,725,000		6,000	25,000	150,000,000	150,000,000	62,725,000	62,725,000	0	62,725,000
B1-4	Section 05300	Asphalt Concrete Binder and Surface Courses						0									
B1-4	05300-01	Anti skid AC surface 3cm	m2	4,244	155,000	657,820,000	657,820,000	549,173,600		6,000	129,400	776,400,000	776,400,000	(118,580,000)	(227,226,400)	108,646,400	(118,580,000)
B1-4	05300-02	AC fine course 5cm	m2	4,266	278,000	1,185,948,000	1,185,948,000	988,005,600		6,000	231,600	1,389,600,000	1,389,600,000	(203,652,000)	(401,594,400)	197,942,400	(203,652,000)
B1-4	05300-03	AC binder course 8cm	m2	4,304	360,000	1,549,440,000	1,549,440,000	1,347,152,000		6,000	313,000	1,878,000,000	1,878,000,000	(328,560,000)	(530,848,000)	202,288,000	(328,560,000)
		(Sub-Total B1-4)				3,735,053,000	3,735,053,000	3,239,088,200			4,392,000,000	4,392,000,000	(656,947,000)	(1,152,911,800)	0	495,964,800	(656,947,000)
<b>B1-5</b>	<b>DIVISION 08 ROAD FURNITURE AND MISCELLANEOUS</b>																
B1-5	Section 08100	Slope Protection															
B1-5	08100-01	Concrete Panel 50cm*50cm*5cm	m2	1,790	500,000	895,000,000	895,000,000	0					895,000,000	0	895,000,000		895,000,000
B1-5	08100-02	Cement Mortar Stone Pitching for Slope Protection	m2	670	3,500,000	2,345,000,000	2,345,000,000	670,670,000		113	1,001,000	112,612,500	112,612,500	2,232,387,500	558,057,500	1,674,330,000	2,232,387,500
B1-5	Section 08150	Sodding and Planting						0									
B1-5	08150-01	Sodding	m2	3,550	36,000	127,800,000	127,800,000	0					127,800,000	0	127,800,000		127,800,000
B1-5	Section 08200	Topsoiling						0									
B1-5	08200-01	Furnishing and Placing Topsoil	m2	3,550	3,000	10,650,000	10,650,000	0					10,650,000	0	10,650,000		10,650,000
B1-5	08200-02	Filling for Topsoiling	m3	355	250,000	88,750,000	88,750,000	0					88,750,000	0	88,750,000		88,750,000
B1-5	Section 08920	Concrete Curb						0									
B1-5	08920-01	Concrete Curb, 47x20x50cm	lm	377	590,000	222,430,000	222,430,000	0					222,430,000	0	222,430,000		222,430,000
		(Sub-Total B1-5)				3,689,630,000	3,689,630,000	670,670,000			112,612,500	112,612,500	3,577,017,500	558,057,500	1,344,630,000	1,674,330,000	3,577,017,500
		Construction auxiliary						0					(1,187,890,440)	(1,187,890,440)	0		(1,187,890,440)
		<b>TOTAL BILL ITEM B (CARRY OVER TO BID PRICE SUMMARY)</b>				33,906,503,000	33,906,503,000	15,580,000,200			13,066,794,						

C1-2	Section 06220	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	AMOUNT COMBINED (A)	BD Cost by FS Unit Price (B)	QUANTITY	UNIT PRICE	AMOUNT	AMOUNT COMBINED (C)	Balance (D)=(A)-(C)	Quantity Change (E)=(B)-(C)	Lack of Item and Quantity	Change of Unit Price	Total
					LOCAL CURRENCY (VND)	LOCAL CURRENCY (VND)				LOCAL CURRENCY (VND)	LOCAL CURRENCY (VND)						
C1-2	Section 06220	Prestressed Concrete															
C1-2	06220-03	Internal Prestressing Tendons - Type 19S15.2	ton	599	172,000,000	103,028,000,000	103,028,000,000	28,808,306,000	726	48,094,000	34,927,786,560	34,927,786,560	68,100,213,440	(6,119,480,560)		74,219,694,000	68,100,213,440
C1-2	06220-04	Internal Prestressing Tendons - Type 3T15.2	ton	70	232,000,000	16,332,800,000	16,332,800,000	3,385,817,600		48,094,000	0	0	16,332,800,000	3,385,817,600		12,946,982,400	16,332,800,000
		PC Bar for Vertical (ø32mm)	ton	28	160,000,000	4,480,000,000	4,480,000,000	1,456,000,000	6	52,000,000	291,200,000	291,200,000	4,188,800,000	1,164,800,000		3,024,000,000	4,188,800,000
		Ducts	m					0	47,303	152,000	7,190,110,720	7,190,110,720	(7,190,110,720)	(7,190,110,720)		0	(7,190,110,720)
C1-2	Section 06400	Reinforcing Steel															
C1-2	06400-01	Reinforcing Steel - Deformed Bars (D ≤ 10mm)	ton	0	26,800,000	0	0	0		20,900,000	0	0	0	0			
C1-2	06400-02	Reinforcing Steel - Deformed Bars (D ≤ 18mm)	ton	1,991	27,000,000	53,770,392,000	53,770,392,000	41,622,266,400	4,539	20,900,000	94,865,100,000	94,865,100,000	(41,094,708,000)	(53,242,833,600)		12,148,125,600	(41,094,708,000)
C1-2	06400-03	Reinforcing Steel - Deformed Bars (18mm<D)	ton	663	27,100,000	17,967,950,400	17,967,950,400	13,857,201,600		20,900,000	0	0	17,967,950,400	13,857,201,600		4,110,748,800	17,967,950,400
C1-2	Section 06800	Bridge Bearings															
C1-2	06800-03	Bearing elastomeric type A1 (3000kN)	each	8	100,000,000	800,000,000	800,000,000	4,318,032,000	8	539,754,000	4,318,032,000	4,318,032,000	(3,518,032,000)	0		(3,518,032,000)	(3,518,032,000)
C1-2	06800-04	Bearing elastomeric type A2 (16000kN)	each	12	750,000,000	9,000,000,000	9,000,000,000	6,477,048,000	24	539,754,000	12,954,096,000	12,954,096,000	(3,954,096,000)	(6,477,048,000)		2,522,952,000	(3,954,096,000)
		Bearing elastomeric type A3 te=83mm	each	240	20,000,000	4,800,000,000	4,800,000,000	0			0	4,800,000,000	0	0	4,800,000,000	4,800,000,000	
C1-2	Section 06900	Deck Waterproofing															
C1-2	06900-01	Deck Waterproofing Membrane	m2	24,720	130,000	3,213,600,000	3,213,600,000	4,647,360,000	13,860	188,000	2,605,680,000	2,605,680,000	607,920,000	2,041,680,000		(1,433,760,000)	607,920,000
C1-2	Section 06910	Expansion Joint															
C1-2	06910-01	Expansion Joint Type A (Δ250)	lm	96	210,000,000	20,160,000,000	20,160,000,000	2,308,224,000	50	24,044,000	1,202,200,000	1,202,200,000	18,957,800,000	1,106,024,000		17,851,776,000	18,957,800,000
		Lighting pole	each					0	84	35,000,000	2,940,000,000	2,940,000,000	(2,940,000,000)	(2,940,000,000)		0	(2,940,000,000)
		Lighting column base, parapet concrete	m3					0	1,347	2,016,000	2,715,602,400	2,715,602,400	(2,715,602,400)	(2,715,602,400)		0	(2,715,602,400)
		Reinforcement of Lighting column base, parapet concrete	ton					0	202	20,900,000	4,222,845,000	4,222,845,000	(4,222,845,000)	(4,222,845,000)		0	(4,222,845,000)
		(Sub-Total C1-2)				528,103,322,400	528,103,322,400	271,333,966,000			389,584,483,240	389,584,483,240	138,518,839,160	(118,250,517,240)	4,800,000,000	251,969,356,400	138,518,839,160
		Construction auxiliary							5%		1,547,922,770	1,547,922,770	(1,547,922,770)	(1,547,922,770)		0	(1,547,922,770)
		Super-T girder															
		Prestressed concrete girder super-T L=40m	nos						96	391,503,000	37,584,288,000	37,584,288,000	(37,584,288,000)	(37,584,288,000)			(37,584,288,000)
		Concrete Slab C30	m3						1,920	2,103,000	4,037,760,000	4,037,760,000	(4,037,760,000)	(4,037,760,000)			(4,037,760,000)
		Reinforcement of conc.slab	ton						384	20,900,000	8,025,600,000	8,025,600,000	(8,025,600,000)	(8,025,600,000)			(8,025,600,000)
		Deck Waterproofing	m2						7,360	188,000	1,383,680,000	1,383,680,000	(1,383,680,000)	(1,383,680,000)			(1,383,680,000)
		Normal A/C Surface Course, thickness=8cm (for Bridge)	m2						7,360	232,000	1,707,520,000	1,707,520,000	(1,707,520,000)	(1,707,520,000)			(1,707,520,000)
		Expansion Joint	m						234	5,357,000	1,253,538,000	1,253,538,000	(1,253,538,000)	(1,253,538,000)			(1,253,538,000)
		Elastomeric bearing	each						192	7,014,000	1,346,688,000	1,346,688,000	(1,346,688,000)	(1,346,688,000)			(1,346,688,000)
		Lighting pole	each						26	35,000,000	910,000,000	910,000,000	(910,000,000)	(910,000,000)			(910,000,000)
		Lighting column base, parapet concrete	m3						714	2,016,000	1,439,625,600	1,439,625,600	(1,439,625,600)	(1,439,625,600)			(1,439,625,600)
		Reinforcement of Lighting column base, parapet concrete	t						107	20,900,000	2,238,390,000	2,238,390,000	(2,238,390,000)	(2,238,390,000)			(2,238,390,000)
		Drainage	each						80	1,840,000	147,200,000	147,200,000	(147,200,000)	(147,200,000)			(147,200,000)
		(Sub-Total C1-2)							10%		60,074,289,600	60,074,289,600	(60,074,289,600)	(60,074,289,600)			(60,074,289,600)
		Construction auxiliary									6,007,428,960	6,007,428,960	(6,007,428,960)	(6,007,428,960)			(6,007,428,960)
C1-3	<b>DIVISION 07 STEEL WORKS</b>																
C1-3	Section 07210	Bridge Rails and name plaques															
C1-3	07210-01	Bridge Name Plaques	each	2	720,000	1,440,000	1,440,000	0			0	0	1,440,000	0	1,440,000		1,440,000
C1-3	07210-02	Bridge Histry Plaques	each	1	720,000	720,000	720,000	0			0	0	720,000	0	720,000		720,000
C1-3	Section 07400	Bridge Drainage															
C1-3	07400-01	Bridge Drainage, Type 1	set	206	1,900,000	391,400,000	391,400,000	397,992,000	158	1,932,000	305,256,000	305,256,000	86,144,000	92,736,000		(6,592,000)	86,144,000
C1-3	07400-03	Bridge Drain PVC Pipe D300mm	lm	2,060	653,000	1,345,180,000	1,345,180,000	0			0	0	1,345,180,000	0	1,345,180,000		1,345,180,000
		(Sub-Total C1-3)				1,738,740,000	1,738,740,000	397,992,000			305,256,000	305,256,000	1,433,484,000	92,736,000	1,347,340,000	(6,592,000)	1,433,484,000
		Construction auxiliary							5%		15,262,800	15,262,800	(15,262,800)	(15,262,800)		0	(15,262,800)
		<b>TOTAL BILL ITEM C1 (CARRY OVER TO BID PRICE SUMMARY)</b>				538,172,702,400	538,172,702,400	278,084,998,000			460,750,163,370	460,750,163,370	77,422,539,030	(182,665,165,370)	6,147,340,000	253,940,364,400	77,422,539,030
C2	<b>SUBSTRUCTURE</b>																
C2-1	<b>DIVISION 03 EARTH WORKS</b>																
C2-1	Section 03200	Structure Excavation															
C2-1	03200-01	Structural Excavation - type A (Open excavation)	m3	280	80,000	22,400,000	22,400,000	0					22,400,000	0	22,400,000		22,400,000
C2-1	03200-02	Structural Excavation - type B (Used steel sheet pile)	m3	27,143	1,600,000	43,428,800,000	43,428,800,000	3,202,874,000	11,475	118,000	1,354,050,000	1,354,050,000	42,074,750,000	1,848,824,000		40,225,926,000	42,074,750,000
C2-1	03200-03	Structural Excavation - type C (Used cofferdam )(under	m3	2,835	1,600,000	4,536,000,000	4,536,000,000	334,530,000		118,000	0	0	4,536,000,000	334,530,000		4,201,470,000	4,536,000,000
C2-1	03200-04	Blinding Stone	m3	0	950,000	0	0	0			0	0	0	0		0	0
C2-1	03200-05	Granular Backfill (Compaction 95%)	m3	17,066	376,000	6,416,816,000	6,416,816,000	7,048,258,000		413,000	0	0	6,416,816,000	7,048,258,000		(631,442,000)	6,416,816,000
		(Sub-Total C2-1)				54,404,016,000	54,404,016,000	10,585,662,000			1,354,050,000	1,354,050,000	53,049,966,000	9,231,612,000	22,400,000	43,795,954,000	53,049,966,000
C2-2	<b>DIVISION 06 CONCRETE</b>																
C2-2	Section 06100	Concrete and Concrete Structures															
C2-2	06100-05	Class B Concrete (30Mpa)	m3	18,259	3,500,000	63,906,500,000	63,906,500,000	48,075,947,000	9,744	2,633,000	25,655,952,000	25,655,952,000	38,250,548,000	22,419,995,000		15,830,553,000	38,250,548,000
C2-2	06100-06	Class E Concrete (25Mpa)	m3	72	2,500,000	180,000,000	180,000,000	133,920,000		1,860,000	133,920,000	133,920,000	180,000,000	46,080,000		180,000,000	
C2-2	06100-09	Class G Concrete (10Mpa)	m3	475	1,500,000	712,500,000	712,500,000	998,450,000	288	2,102,000	605,376,000	605,376,000	107,124,000	393,074,000		(285,950,000)	107,124,000
		Blinding concrete	m3					0	5,760	1,800,000	10,368,000,000	10,368,000,000	(10,368,000,000)	(10,368,000,000)		0	(10,368,000,000)
C2-2	Section 06210	Cast-in-Place Pile															
C2-2	06210-01	Cast-in-place Concrete Pile, dia.1500mm	lm	7,800	28,000,000	218,400,000,000	218,400,000,000	118,458,600,000	5,200	15,187,000	78,972,400,000	78,972,400,000	139,427,600,000	39,486,200,000		99,941,400,000	139,427,600,000
C2-2	06210-02	Cast-in-place Concrete Pile															

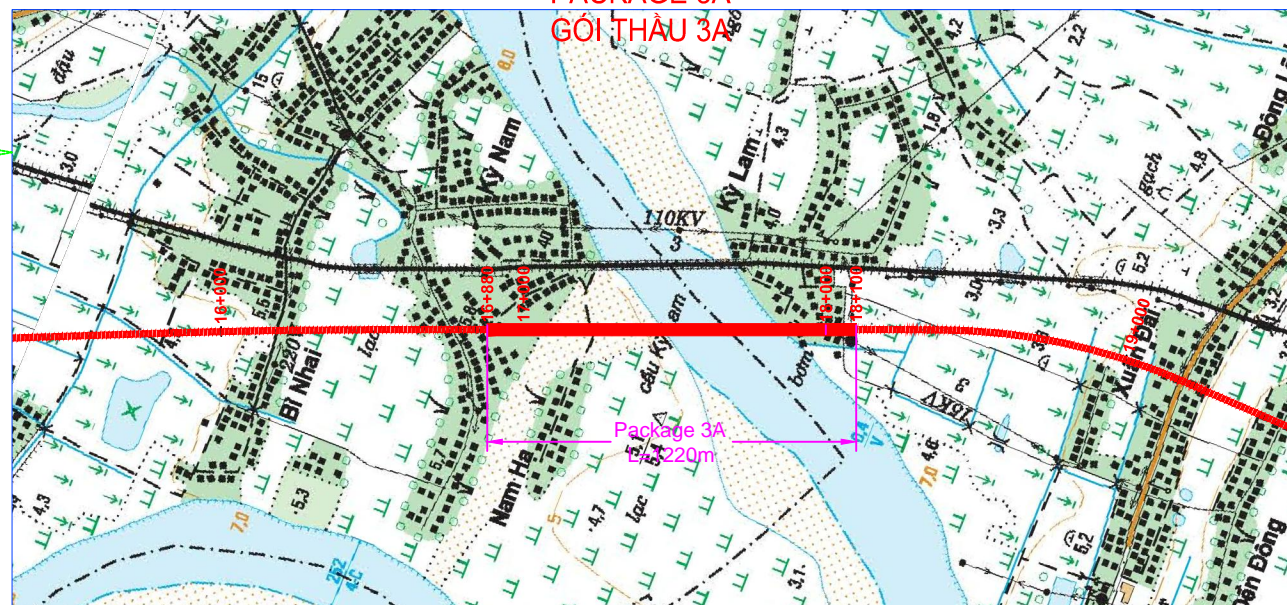
**Appendix 5**  
**Basic Design of Road Embankment**

LOCATION MAP OF DA NANG - QUANG NGAI EXPRESSWAY  
 BẢN ĐỒ TỔNG THỂ ĐƯỜNG CAO TỐC ĐÀ NẴNG - QUẢNG NGÃI



PACKAGE	01	02	3A	3B	04	05	06	07	A1	A2	A3	A4	A5
LENGTH (m)	8000	8880	2200	3400	11100	9400	10000	13000	16150	18350	10600	14600	14563

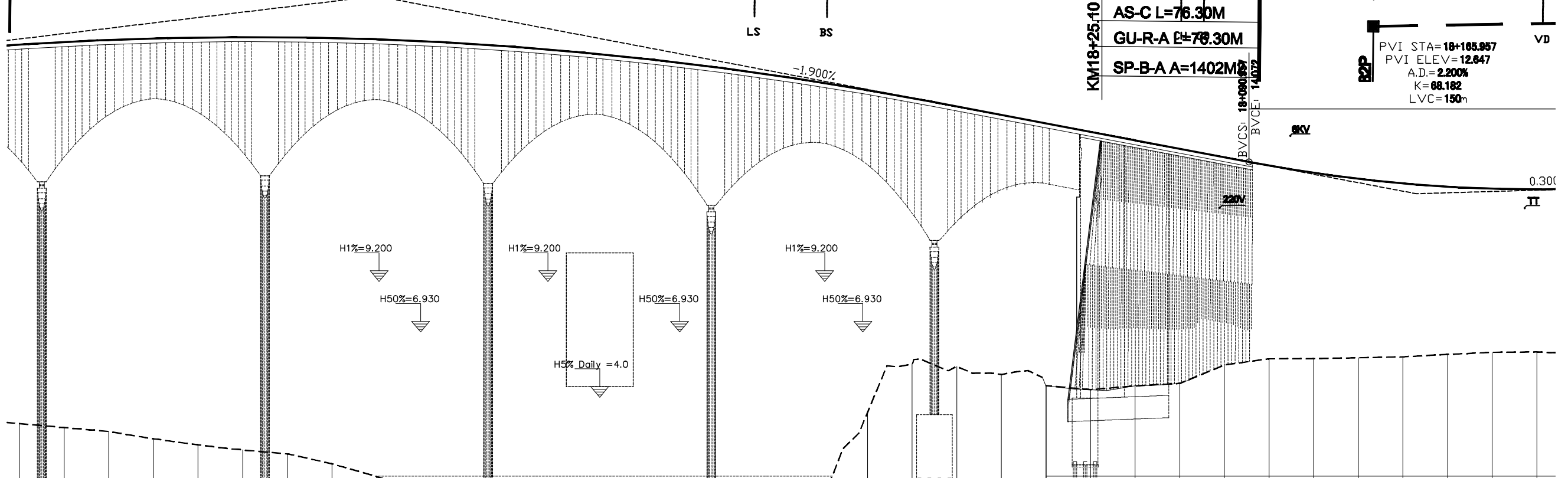
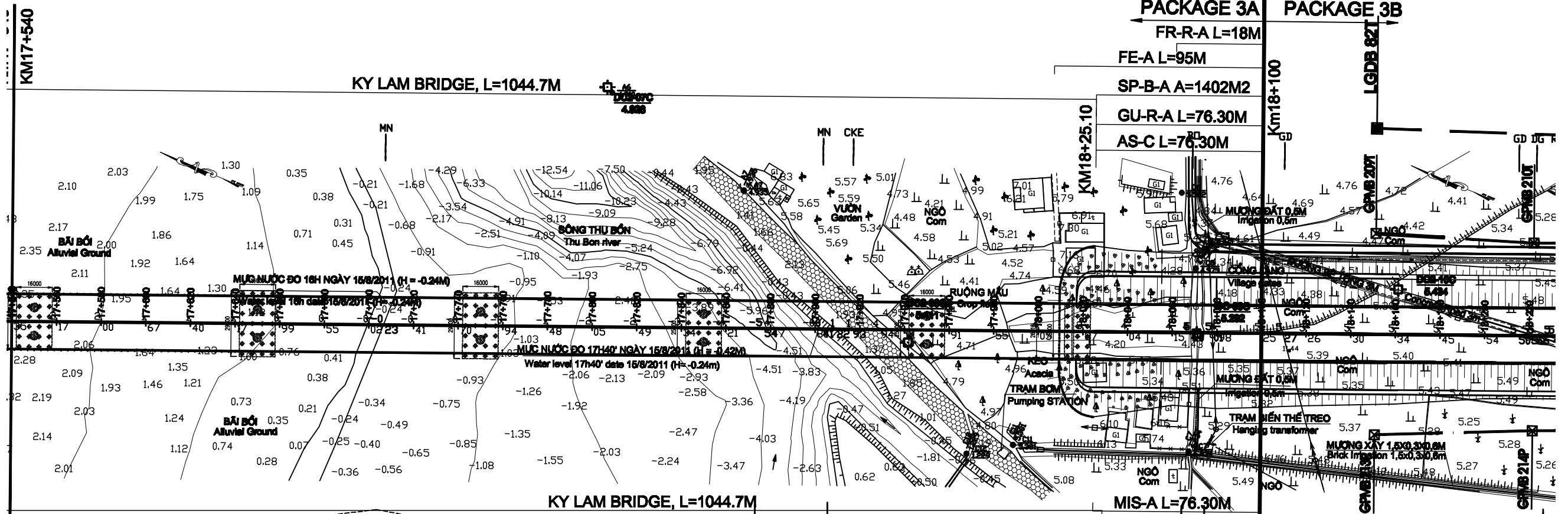
PACKAGE 3A  
 GÓI THẦU 3A



File: E:\001-DCE\001-Working\Package 3A\A. General Drawings\P3A-RW-GD-020.dwg May 23, 2012 - 3:05 PM

MINISTRY OF TRANSPORT VIETNAM		ENGINEERING DESIGN CONSULTANT		REMARKS:	DA NANG-QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT							
CLIENT		PROJECT MANAGEMENT CONSULTANT			Package: 3A Station: Km16+880 - Km18+100							
VIETNAM EXPRESSWAY CORPORATION		PROJECT MANAGEMENT UNIT NO.85			The Joint Venture of Nippon Koei Co., Ltd. Nippon Engineering Consultants Co., Ltd. Chodal Co., Ltd. Thai Engineering Consultants Co., Ltd.		PREPARED BY	CHECKED BY	APPROVED BY	DRAWING TITLE		
						NAME	P.V. HUNG	T. NAGAI	I. ISHIMOTO	SCALE	DRAWING NO.	REV. NO.
						SIGNATURE					P3A-RW-	
						DATE						

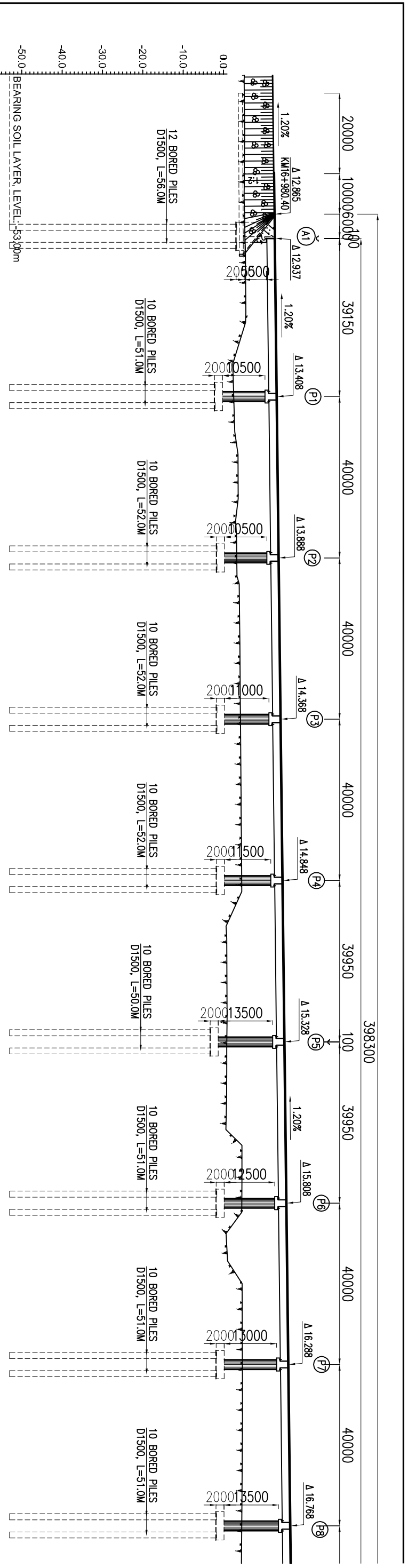




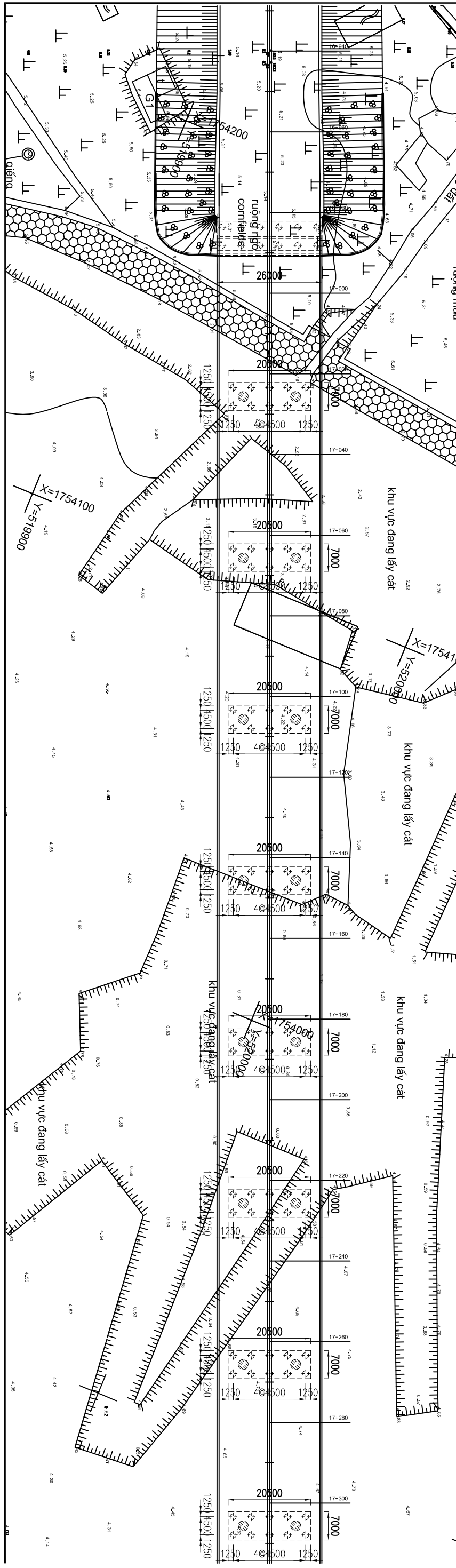
PROPOSED HEIGHT	17+540 19.560	17+560 19.820	17+580 20.080	17+600 20.300	17+620 20.540	17+640 20.780	17+660 21.020	17+680 21.260	17+700 21.500	17+720 21.740	17+740 22.000	17+760 22.240	17+780 22.480	17+800 22.720	17+820 22.960	17+840 23.200	17+860 23.440	17+880 23.680	17+900 23.920	17+920 24.160	17+940 24.400	17+960 24.640	17+980 24.880	18+000 25.120	18+020 25.360	18+040 25.600	18+060 25.840	18+080 26.080	18+100 26.320	18+120 26.560	18+140 26.800	18+160 27.040	18+180 27.280	18+200 27.520	18+220 27.760
EXISTING HEIGHT	2.348	2.168	1.987	1.667	1.400	1.170	0.990	0.550	-0.020	-0.410	-0.700	-0.940	-1.480	-2.050	-2.490	-3.340	-4.210	-4.480	-0.790	2.830	5.010	4.910	4.550	4.050	3.870	4.040	4.150	4.976	5.250	5.260	5.300	5.340	5.450	5.540	5.560
STATION	17+540	17+560	17+580	17+600	17+620	17+640	17+660	17+680	17+700	17+720	17+740	17+760	17+780	17+800	17+820	17+840	17+860	17+880	17+900	17+920	17+940	17+960	17+980	18+000	18+020	18+040	18+060	18+080	18+100	18+120	18+140	18+160	18+180	18+200	18+220

MINISTRY OF TRANSPORT VIETNAM		ENGINEERING DESIGN CONSULTANT		REMARKS:		DA NANG-QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT Package: 3A Station: Km16+880 - Km18+100					
CLIENT	PROJECT MANAGEMENT CONSULTANT	The Joint Venture of Nippon Koei Co., Ltd. Nippon Engineering Consultants Co., Ltd. Chodai Co., Ltd. Thai Engineering Consultants Co., Ltd.				PREPARED BY	CHECKED BY	APPROVED BY	DRAWING TITLE		
VIETNAM EXPRESSWAY CORPORATION	PROJECT MANAGEMENT UNIT NO.85					P.V. HUNG	T.NAGAI	I. ISHIMOTO	PLAN+PROFILE: STA17+540+~STA18+100		
						SIGNATURE	SCALE	DRAWING NO.	REV. NO.		
						DATE	1:2000, 1:200	P3A-RW-			

**Appendix 6**  
**Basic Design of Bridge**



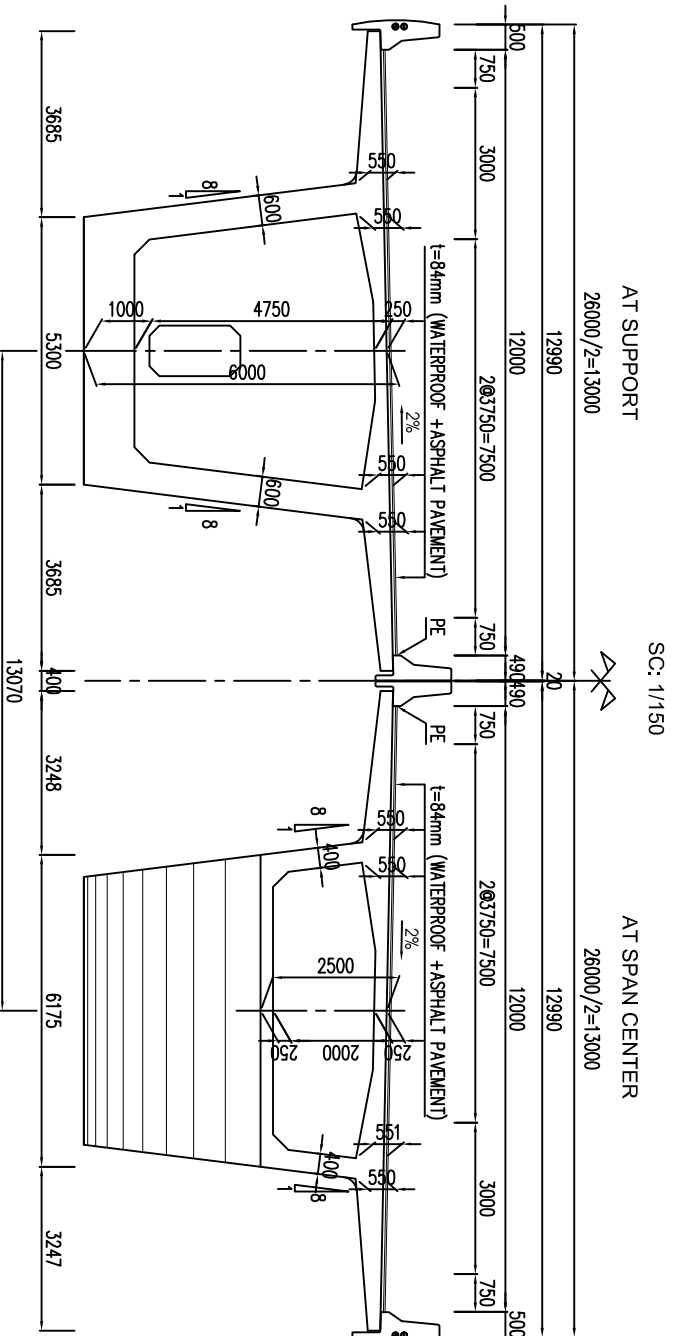
STATION	EXISTING HEIGHT	PROPOSED HEIGHT
16+880	5.280	12.740
16+960	5.154	12.860
16+976.4	5.220	12.860
16+980	5.359	13.100
16+986.4	5.550	13.100
17+000	2.400	13.340
17+020	2.569	13.340
17+25.65	3.630	13.580
17+040	3.250	13.820
17+060	3.322	14.060
17+65.65	4.020	14.300
17+080	4.180	14.540
17+100	4.225	14.780
17+105.65	4.340	15.020
17+120	4.500	15.260
17+140	4.546	15.500
17+145.65	0.830	15.740
17+160	0.910	15.980
17+180	0.840	16.220
17+185.65	0.790	16.460
17+200	4.590	16.700
17+200	4.554	16.940
17+220	1.065	17.180
17+220	4.690	17.420
17+240	4.705	17.660
17+240	4.710	17.900
17+260	4.610	18.140
17+260	4.556	18.380
17+280	4.610	18.620
17+280	4.556	18.860
17+300	4.610	19.100
17+300	4.556	19.340



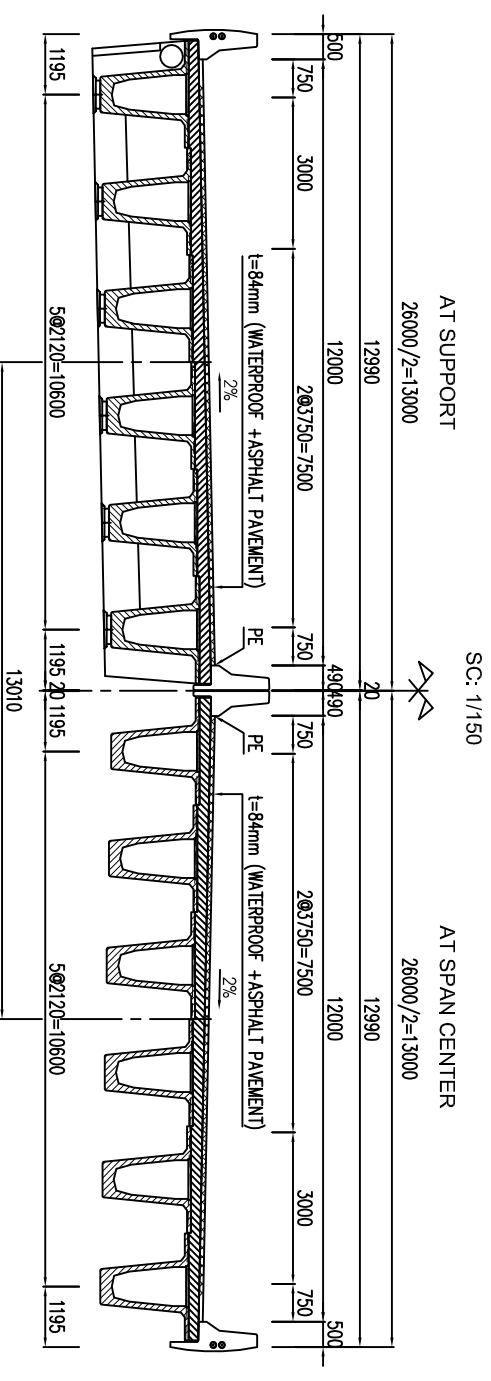




## TYPICAL CROSS SECTION OF MAIN BRIDGE



## TYPICAL CROSS SECTION OF APPROACH BRIDGE



### River Condition

Item	Design Value	
River Name	Thu Bon River	
Administrator	IV	
Intersection Location	KM 020+305	
Intersection Angle(°)	90°	
H1%River Condition	DHWL 1%	9.2 m
	Velocity	3.44 m/sec
	Discharge	23,655 m <sup>3</sup> /sec
Freeboard	Bridge Opening	880 m
	DWL 50%	1.0 m
H50%River Condition	DWL 50%	7.07 m

### Navigation (TCVN 5664-2006)

Item	Design Value	
River Name	Thu Bon River	
Class	IV	
River Condition	H5%,Daily Average WL	4.07
	Velocity	1.15
	Vertical	6.0
Clearance	Horizontal	30.0

### General Condition

Route	Da Nang - Quang Ngai Expressway					
Investment	VEC					
Road Class and Velocity	Road Class	Type A/Grade 120				
	Design Speed	120 km/hr				
Location	Province	Quang Nam				
	District	Dien Ban				
	Commune	Dien Tho & Dien Quang				
Cross Section	Total Parapet(m)	Safety(m)	Lanes Vehicle(m)	Safety(m)	Parapet(m)	Space(m)
	2 x ( 0.50+ 0.75+ 3.00+ (2 x 3.75 =7.50) +0.75 +0.49) +0.02					
	Total Width	26.00m	Effective With Be=	24.00m		
Bridge Class	Operation Importance	Typical Bridge				
	Analysis for Earthquake	Essential Bridge				
Live Load	Zone		District		Dien Ban	
	Acceleration Coefficient	II		0.0341		
Seismic	Soil Profile Type		II		Site Coefficient	1.2
	Bridge Length and Bridge Center		1044.70 m			
Superstructure	Span Arrangements		10 Spans Super T Girder + 7 Spans PC Box Girder			
	Material	Type	Continuous Deck slab and Continuous Girder			
		Concrete	f <sub>c</sub> = 45Mpa			
PC Steel	Longitudinal: 19S15.2(b) Transvasal: 3S15.2(B)					
Reinforcing Bar	f <sub>sy</sub> = 400Mpa					
Substructure	Material	Type	T Abutments, Circle Shape Piers			
		Concrete	f <sub>c</sub> = 30Mpa			
Reinforcing Bar	f <sub>sy</sub> = 400Mpa					
Foundation	Material	Cast in Bored Pile, Diameter D1.5m				
		Concrete	f <sub>c</sub> = 30Mpa			
Reinforcing Bar	f <sub>sy</sub> = 400Mpa					
Main Design Standard		22TCN-272-05; Reference AASHTO 1998				

MINISTRY OF TRANSPORT VIETNAM

ENGINEERING DESIGN CONSULTANT

REMARKS:

DA NANG-QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT

Package: 3A

Station: KM16+880.00 -; KM18+100.00

CLIENT  
VIETNAM EXPRESSWAY CORPORATION

PROJECT MANAGEMENT CONSULTANT  
PROJECT MANAGEMENT UNIT NO.85

ENGINEERING DESIGN CONSULTANT

GENERAL VIEW OF KY LAM BRIDGE

PREPARED BY  
Nguyen Van Le

CHECKED BY  
Hiroyuki Yokoyama

APPROVED BY  
Yoshiko Oba

DRAWING TITLE  
GENERAL VIEW OF KY LAM BRIDGE

SCALE  
AS SHOW

DRAWING NO.  
REV. NO.  
0

PROJECT MANAGEMENT CONSULTANT  
UNIT NO.85

The Joint Venture of  
Nippon Koei Co., Ltd.  
Nippon Engineering Consultants Co., Ltd.  
Chodai Co., Ltd.  
Thai Engineering Consultants Co., Ltd.

REMARKS:

DA NANG-QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT

Package: 3A

Station: KM16+880.00 -; KM18+100.00

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