SOCIALIST REPUBLIC OF VIETNAM
VIETNAM EXPRESSWAY CORPORATION

PREPARATORY SURVEY REPORT
ON
Phap Van-Cau Gie EXPRESSWAY PROJECT
IN
SOCIALIST REPUBLIC OF VIETNAM

March 2012

JAPAN INTERNATIONAL COOPERATION AGENCY（JICA）

Katahira & Engineers International
Central Nippon Expressway Company Limited
ITOCHU Corporation

OPS
JR(先)
12-010

TABLE OF CONTENTS

List of Figures and Tables

List of Figures

List of Tables

Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Official
ADB	Asian Development Bank
BCR	Benefit Cost Ratio
BIDV	Bank for Investment and Development of Vietnam
BOD	Biochemical Oxygen Demand
BOT	Build-Operate-Transfer
BT	Build-Transfer
BTO	Build-Transfer-Operate
CCTV	Closed-circuit television
DARD	Dept. Of Agriculture and Rural Development
DOE	Department of Environment
DRVN	Directorate of Road in Vietnam
DSCR	Debt Service Coverage Ratio
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
Equity IRR	Equity Internal Rate of Return
EPC	Environmental Protection Commitment
EMO	Expressway Management Office
EMP	Environmental Management Plan
FS	Feasibility Study
GDP	Gross Domestic Product
GNI	Gross National Income
GoV	Government of Vietnam
HOUTRANSS	The Study on the Urban Transport Master Plan and Feasibility Study in Hochiminh Metropolitan Area, JICA, 2004
IDC	Interest During Construction
IFC	International Finance Corporation
IOL	Inventory of Losses
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
LEP	Law on Environmental Protection
LLCR	Loan Life Coverage Ratio
LOS	Level of service
MARD	Ministry of Agriculture and Rural Development
METI	Ministry of Economy, Trade and Industry, JAPAN
MOC	Ministry of Construction
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MPI	Ministry of Planning and Investment
NEXCO中日本	Central Nippon Expressway Company Limited
NEXI	Nippon Export and Investment Insurance
NH	National Highway
NPV	Net Present Value
OD	Origin and Destination
O&M	Operation and Maintenance
PAPs	Project Affected Persons
PCE	Passenger Car Equivalent
PCU	Passenger Car Unit
PDOT	People's Department of Transportation

PM	Particular Matter
PPP	Public-Private Partnership
PV-CG	Phap Van – Cau Gie
QCVN	Vietnam Technical Regulations
ROW	Right-of-Way
RAP	Resettlement Action Plan
SEA	Strategic Environmental Assessment
SOE	State- owned enterprise
SPC	Specific Purpose Company
SS	Suspended substance(solids)
TCVN	Vietnam Standards
TSP	Total Suspended Particle
TSS	Total Suspended Solids
TTC	Travel Time Cost
USD	United States Dollar
UXO	Unexploded Ordnance
VAT	Value Added Tax
VEC	Vietnam Expressway Cooperation
VITRANSS 2	The Comprehensive Study on the Sustainable Development of Transport System in Vietnam, JICA, 2010
VND	Vietnam Dong
VOC	Vehicle Operating Cost
WACC	Weighted average cost of capital

1. Introduction

1.1 Background and Objectives of the Study

1.1.1 Background of the Study

Ministry of Transport, Socialist Republic of Vietnam (hereinafter referred to as MOT) conducted the master plan entitled: "Expressway Network Master Plan in Vietnam (-2020)" in August 2005, and presented mid- & long-term Expressway Network Plan covering the period until 2025.
"Expressway Development Plan (Master Plan)," approved by the Prime Minister in December 2008, set the target for development of approximately 5,873km of expressways with 39 sections, and planned to develop 2,235km expressway by 2020. The Vietnam Expressway Corporation (hereinafter referred to as VEC), founded in 2004, is responsible for the development and investment in the expressways. VEC continues to pursue its development mandate.

Based on the Master Plan and VEC's mandate, the Prime Minister approved the detailed plan of North-South Expressway which connects Hanoi in Northern Vietnam and Canto in Southern Vietnam. The portion of Phap Van-Cau Gie (hereinafter referred to as PV-CG) is located with its starting point at the North-South Expressway in the southern part of Hanoi city. The project scope covers upgrading of the Bypass of National Route 1, which is currently in service and opened to the public - opened in 2002 with four-lanes and toll free. PV-CG Expressway project (hereinafter referred to as the Project) will involve the application of expressway standards and widening to six lanes. The list of Priority Projects listed in the road sectors identified in the attachment to the Prime Minister's Decision No. 05/2011/QD-TTg and as indicated in the Approval of the Transport Infrastructure Projects in Northern Economic Area, issued on 24 January 2011, includes PV-CG Expressway (32.3km, 6 lanes).

VEC was granted a right to implement the Project in April 2010 by MOT. Because VEC has been engaged in other expressway projects and this strained VEC's investment capacity, alternative implementation schemes, which utilize private-sector fund that would relieve excessive financial burden to VEC, were examined and evaluated.

1.1.2 Objectives of the Survey

The objectives of the Study are to formulate a basic infrastructure development plan as proposed by Private Sector proponents; and to verify its validity, effectiveness and efficiency. It is based on the following two conditions:
- Private sector undertakes to develop infrastructure project from design, construction, operation and to maintenance using equity or debt financed by ODA funds from public financial institutions, etc.; and
- In ODA funds, JICA Private Sector Investment Finance (PSIF) is considered as the prime source of funding .

1.2 Subject and Scope of Study

1.2.1 Survey Area

PV-CG Expressway is located with its starting point at the North-South Expressway in the southern part of Hanoi city as shown in the Figure 1.2.1-1 below.

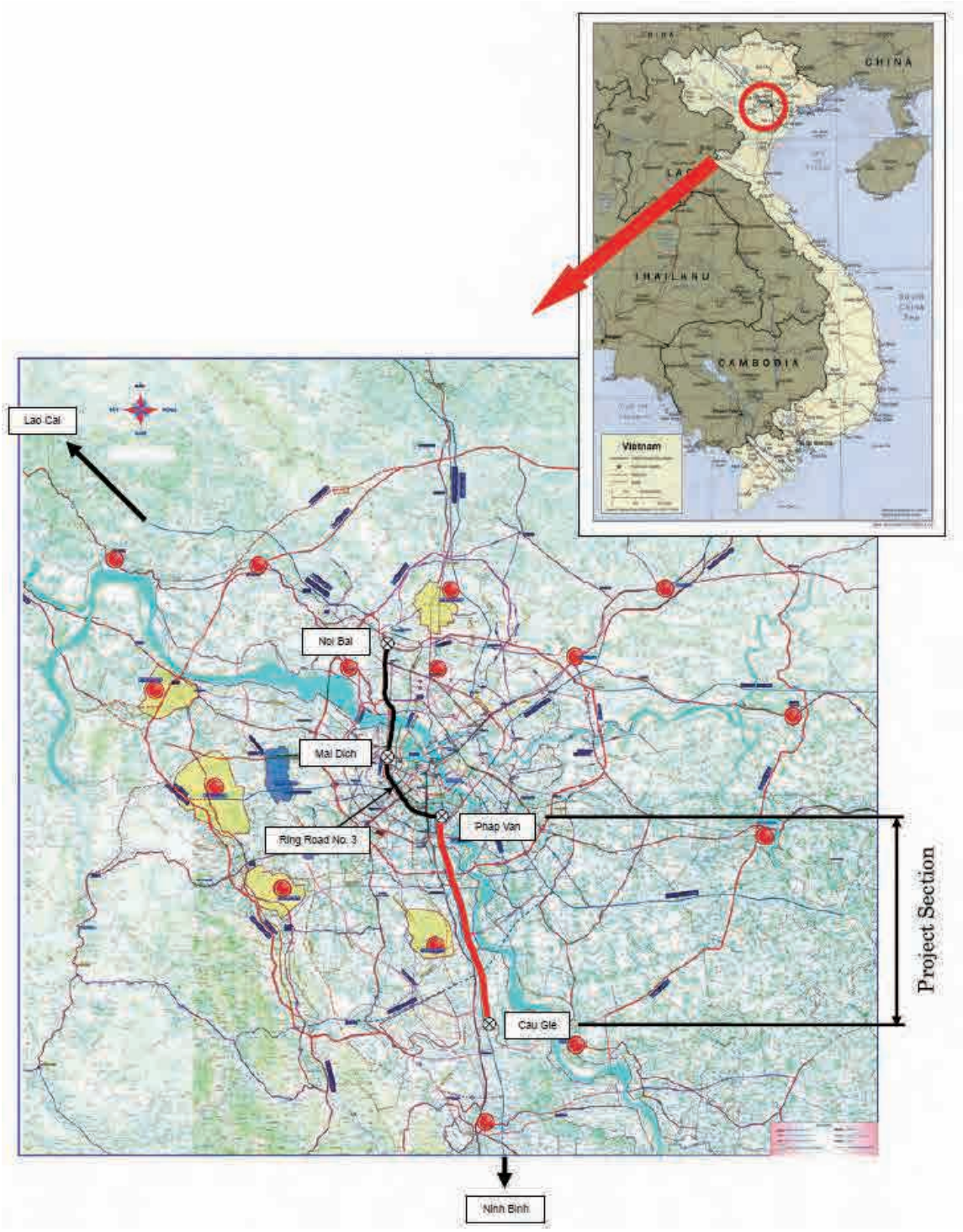


Figure 1.2.1-1 Survey Area

1.2.2 Scope and Contents of the Study

1.2.2.1 Scope of Study

The area to be studied covers an alignment that is 28.956 km in length on PV-CG Highway (Km182+300～Km211+248.96).

32.3km appears on the Prime Minister decision with the starting point at intersection of PV-CG Highway and Ring Road No.3 and the ending point at connection with the old NH No.1. Scope of study is between Phap Van IC at the starting point and Dai Xuyen IC at the ending point excluding these two ICs which are almost completed under the Cau Gie-Ninh Binh Project.

1.2.2.2 Contents of the Study

(1) Preparation for Project Implementation Program:

1) Study of Project Implementation Program

2) Formation of Project Implementing Organization

3) Preparation of Inception Report

(2) Project Proposal confirming the Project Background and its Necessity:

1) Current Status and Issues on Expressway Sector in Vietnam,

2) Policies and Government's Development Plan on Expressway Sector in Vietnam

3) Current and Prospective Situation of Project-related Legislation in Vietnam

4) Current and Prospective Situation of other Foreign Companies/Investors to the Project

5) Current Situation in the Project Areas including current and prospective business activities by other foreign Companies

6) Necessity of Project

7) Confirmation of Existing System on Environmental and Social Consideration and its mitigation measures

(3) Proposal of Project Implementation Program

1) Formulation of the Project

2) Outline Design

3) Economic and Financial Analysis

4) Environmental and Social Considerations and its mitigation measures

1.2.2.3 Project Outline

Construction of the Project will be carried out in two stages (Phase 1: Improvement of the existing 4-lanes plus land acquisition and Improvement of frontage road. Phase 2: Road widening to 6 lanes). In Phase 1, not only toll collection but also operation and maintenance of expressway will be carried out soon after the completion of the Project.

Acquisition of land required for frontage road improvement and widening to 6 lanes will be

carried out by the Government of Vietnam immediately after completion of required procedures in accordance with the Decree No. 69/2009/ND-CP for land acquisition.
It would be noted that the cost for this Right-of-Way acquisition shall be basically borne by the Government of Vietnam.
Table 1.2.2-1 enumerates the main works to be undertaken for the Project.

Table 1.2.2-1 Major Works

Phase	Contents of Main Works (Length of Road: 28km)
Phase 1	Before Land Acquisition ・Detailed Design ・Pavement Improvement of existing 4 lanes ・Repair of existing road structures (movement joints, cracks etc.) ・Road Operation and Maintenance
Phase 2	After Land Acquisition ・Detailed Design ・Construction of frontage roads ・Extension of drainage ・Road widening to 6 lanes ・Extension of culverts for traffic ・Counter measures for soft ground ・Road Operation and Maintenance

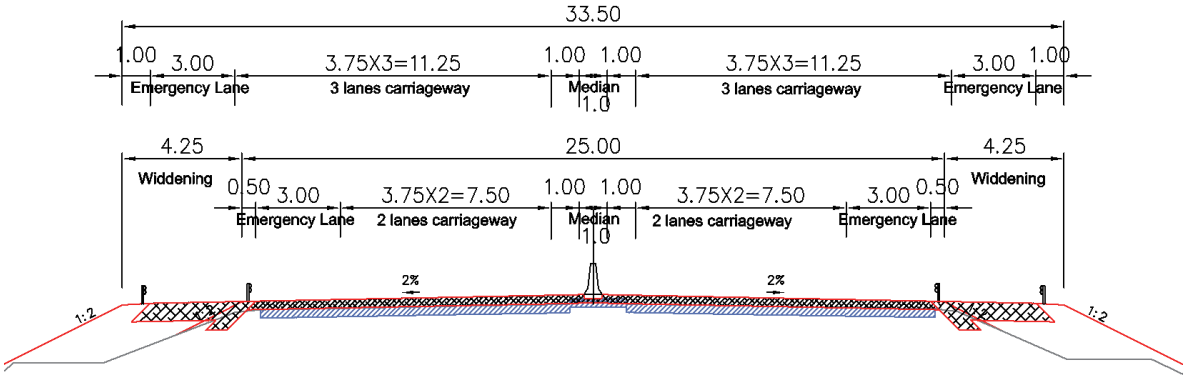


Figure 1.2.2-1 Widening to 6 Lanes Standard Cross Section

The project schedule is shown in Figure 1.2.2-2.

It is assumed that the completion of improvement of the existing road and the commencement of toll collection will be at the middle of 2014. Phase 2 is expected to be completed by the end of 2019. And the operation period will be 20 years from the commencement of toll collection (operation period will be completed at the middle of 2034.)

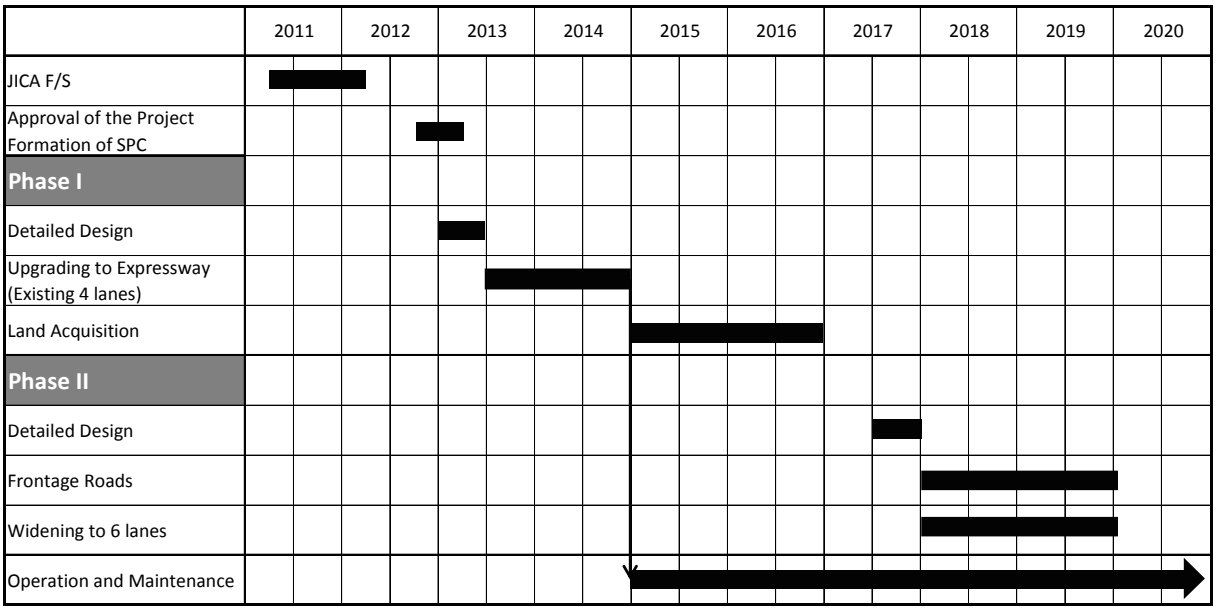


Figure 1.2.2-2 Current Project Schedule

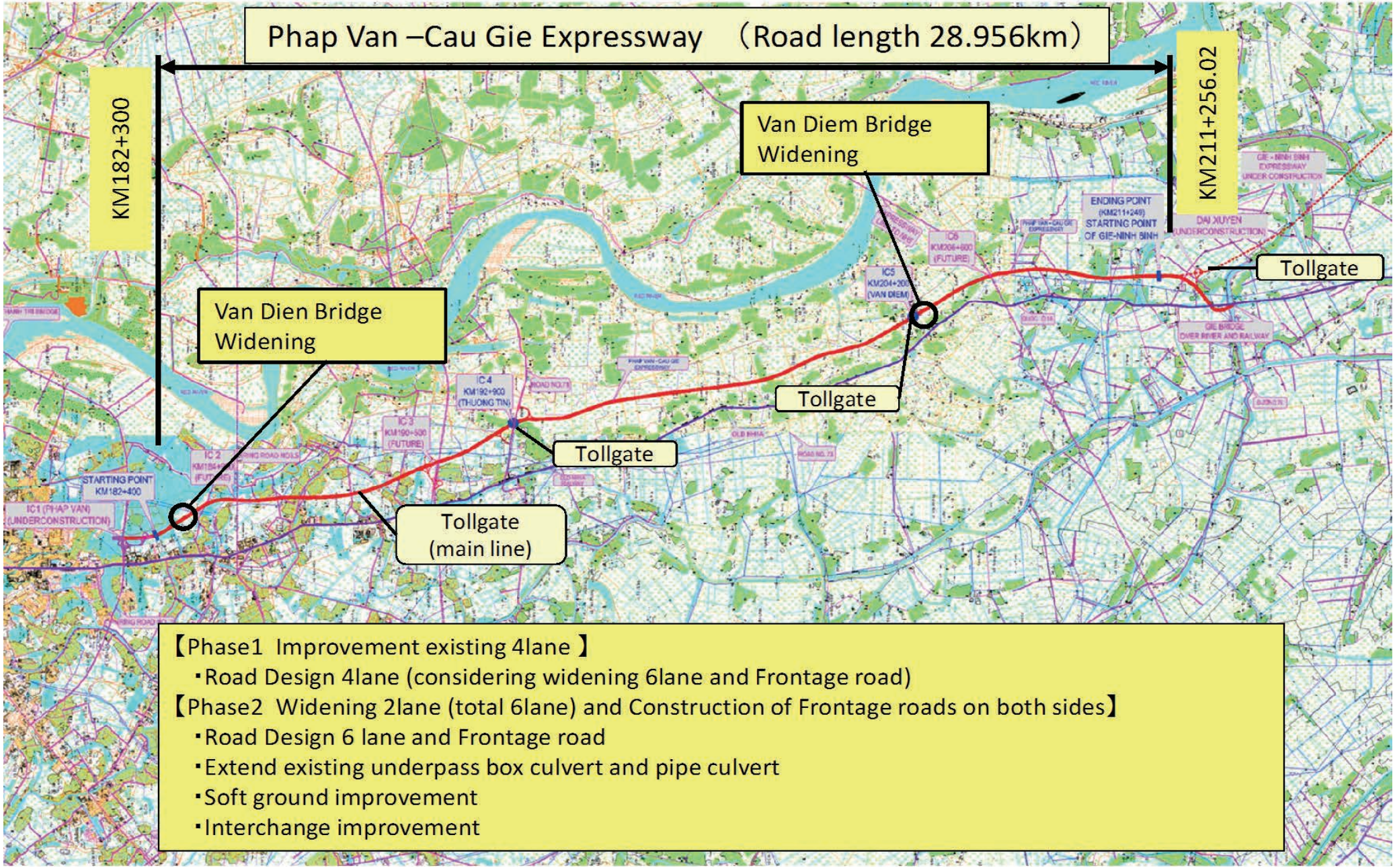


Figure 1.2.2-3 Major Design Items

1.3 Organization of Study Team

Organization of study team is shown in Figure 1.3.1-1 and study team members are shown in Table 1.3.1-1.

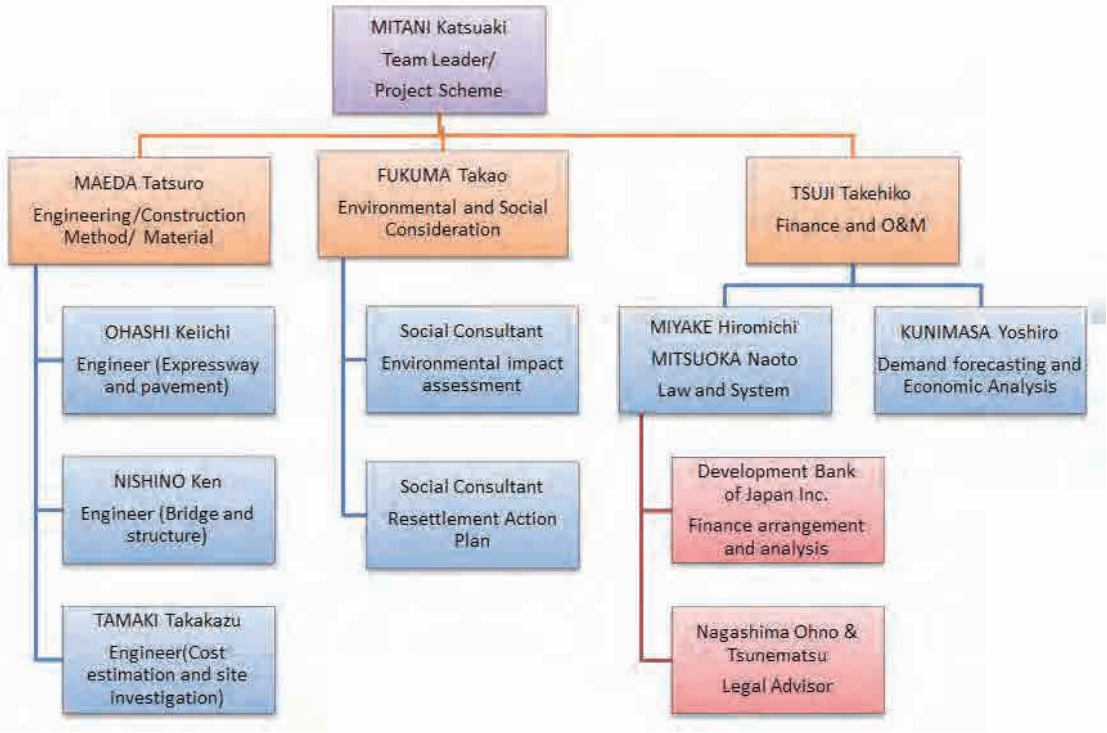


Figure 1.3.1-1 Organization of Study Team

Table 1.3.1-1 Study Team Member

Name	Role	Firm
MITANI Katsuaki	Team Leader／Project Scheme	KEI
MAEDA Tatsuro	Engineer／Construction method／Material	KEI
TSUJI Takehiko	Expressway Operation and Maintenance Specialist	C-NEXCO
MIYAKE Hiromichi	Law and System Specialist 1	C-NEXCO
MITSUOKA Naoto	Law and System Specialist 2	ITOCHU
KUNIMASA Yoshiro	Demand forecasting and Economic Analysis Specialist	KEI
OHASHI Keiichi	Design Engineer(Expressway and pavement)	KEI
NISHINO Ken	Design Engineer(bridge and structure)	KEI
TAMAKI Takakazu	Engineer(Cost estimation and site investigation)	KEI
FUKUMA Takao	Environmental and Social Consideration Expert	KEI

Note) KEI : Katahira & Engineers International
C-NEXCO : Central Nippon Expressway Company Limited
ITOCHU : ITOCHU Corporation

1.4 Study Schedule

Study schedule is shown in the chart, below.

Table 1.4.1-1 Study Schedule

Items	Progress Rate	2011 Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2012 Jan	Feb	Mar
1.Preparation of survey	100%												
2.Survey and Study of PPP project formulation													
(1) Demand forecasting for project	100%												
(2) Review of project	100%												
(3) Study of project enforcement system	100%												
(4) Establish project enforcement schedule	100%												
(5) Study of management and maintenance plan	100%												
3.Outline design													
(1) Outline design	100%												
(2) Planning of construction	100%												
(3) Planning of pavement	100%												
(4) Project Cost Estimation	100%												
4.Economic and financial analysis													
(1) Financial analysis of private sector	100%												
(2) Economic analysis of the whole project, Study on operation and effectiveness indicator.	100%												
5.Environmental and Social Consideration	100%												
6.Reports	80%												
7.Explanation,conference													
(1) Inception report	100%												
(2) Interim report	100%												
(3) Draft final report	0%												
(4) Final report	0%												

2. Background and Necessity of the Project

2.1 Current Status and Issues of Expressway in Vietnamese

2.1.1 Present Organization Structure concerning Expressway

This section clarifies present organization structure and its jurisdictions concerning Expressway in Vietnam.

(1) Ministry of Transport (MOT)

The Ministry of Transport (MOT) is a government agency in charge of state management of land transport (highways, railways), inland waterway transport and maritime transport across the country. There are 5 administrations under MOT.

Expressway Management Office (hereinafter referred to EMO) was established in accordance with Decision No.633/QD-BGTVT in April 2011. EMO has tasks of leading in researches and proposals for policies, regulations related to construction investment, management, operation, maintenance of expressway and to be a contact point assisting leaders of transport in relation with Ministries, calling for and promote investment. EMO will reorganize as Directorate of Expressway in Vietnam (DEVN) in the near future.

Table 2.1.1-1 Organization under jurisdiction of MOT

Organization	Jurisdiction
Directorate of Road in Vietnam (DRVN)	Road Transport and Traffic, but excluding Expressway
Expressway Management Office (EMO)	Expressway
Vietnam Inland Waterway Administration	Inland Waterway
Vietnam National Maritime Bureau	Maritime
Vietnam Register	Vehicle and Vessel Registration
Transport Construction Quality Control and Management Bureau	Construction Management

MOT is responsible for submitting Development Strategy and Implementation Plan of Expressway to the Prime Minister. In this regards, the Prime Minister approved Vietnam Expressway Network Developing and Planning until 2020 and the view for post 2020 (Decision No. 1734 / QD-TTg) in 1st December 2008 based on Submission No. 7056/TTr-BGTVT by MOT in May 2007.

MOT is also responsible for issuing construction standards and constructions standards for expressway. TCVN 5729-1997 is being under review from 2007, based on experiences obtained in design and construction of several expressways, to which TCVN 5729-1997 was applied. In the seminar on Expressway in Vietnam joint hosting by MOT and Ministry of Infrastructure, Land, Transport and tourism of JAPAN (MILT) held in August 2011, outline of revision to TCVN 5729-1997 was briefed. The objectives of revisions are as follows.

- To increase safety
- To save construction costs
- To reduce the area of land use
- To match with the complex terrain

(2) Vietnam Expressway Cooperation (VEC)

The Vietnam Expressway Cooperation (VEC) was established as State-owned Company under

MOT in 2004 for investment, development and management, maintenance of national expressway system. After reorganized as a holding company in July 2010, VEC at present is a one-member Ltd. Company owned by MOT. VEC has been frequently reorganized the structure to meet increasing task assignment for implementing projects and changing project stage such as investment, F/S, Design, Construction and operation of expressway. Present organization chart is shown in Figure 2.1.1-1Figure 2.1.1-1Figure 2.1.1-1

VEC is executing agency for following 6 expressways from 5,873km expressway M/P[1] at present.

(1) Cau Gie-Ninh Binh expressway: 56km, under construction with partial opening on Novemver2011, fully open in 2012.
(2) Noi Bai-Lao Cai expressway: 264km, under construction, open in 2014.
(3) HCM-Long Thanh-DauGuay expressway: 54.9km, under construction, open in 2014.
(4) Da Nang-Quang Ngai expressway: 139.5km, preparing for DD, open in 2014.
(5) Ben Luc- Long Thanh expressway: 57.8km, DD, open in 2017.
(6) Phap Van-Cau Gie expressway: 28km, F/S, This study.

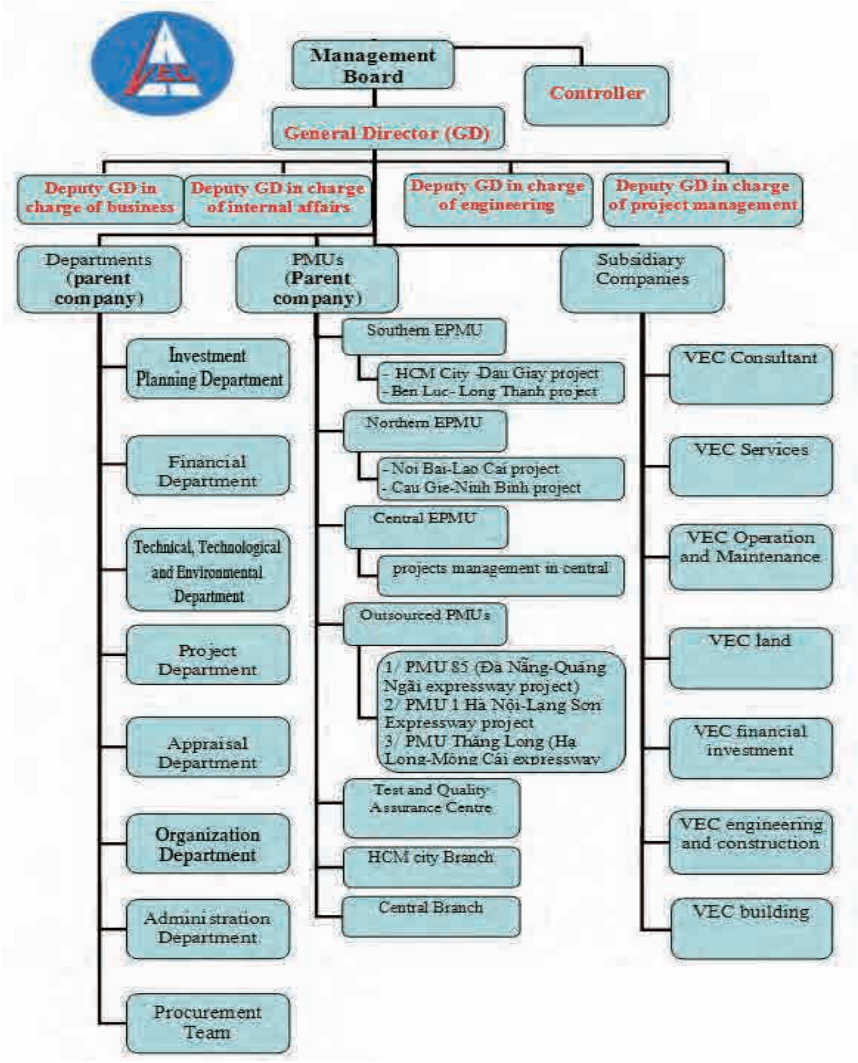


Figure 2.1.1-1 Organization Chart of VEC Source: VEC Web Site

[1] Decision1734/QD-TTg：Approval of Vietnam Expressway Network Developing and Planning until 2020 and the view for post-2020

(i) Financial Situation

Balance Sheets and Profit and Loss Statement from 2006 to 2010 of VEC is shown in the following **Table 2.1.1-2** and **Table 2.1.1-3**.

(a) At the macro level, the amount of Vietnam's public debt has exceeded 50% of GDP and is nearing to 60%.At the micro level, on the other hand, the total amount of VEC's debt consisting of ODA loans and bonds has exceeded US$3bil and is expected to reach US$5bil in 2011. It is desirable to formulate the project in such a manner as minimizing the financial burden to Vietnamese side.

(b) VEC totally depends on interest revenue accrued from bank deposit and working expenditure in the on-going projects allocated by ODA loans for their administrative costs. VEC opened one section in Cau Gie –Ninh Binh Expressway, or 23km between Cau Gie-Phu Ly, on November 13, 2011 and started its operation and maintenance. As the first repayment of its ODA loan is scheduled to begin in 2016, it is desirable that VEC starts soon the operation, or the collection of toll, of Phase I of Phap Van–Cau Gie Expressway just succeeding to the operation of the section mentioned above in order to secure the recurring cash flow.

(c) At present, the fixed assets of PV-CG Highway possessed by the DRVN are being assessed. Once the assessment is completed, balance sheet of VEC will be improved.

(d) The principal repayment for the loans for 5 expressways will commence from 2014 and the amount of repayment will keep increasing. According to ADB, depending upon the increase of traffic volume and toll revenue, VEC's financial position is expected to become stable after 2025. In this regard, VEC has no alternative but to apply a project scheme utilizing private sector fund such as BOT or PPP, as well as traditional procurement method like bonds or equity reinforcement.

Table 2.1.1-2 VEC's Balance Sheet

VEC's Balance Sheet is not disclosed.

Table 2.1.1-3 VEC's Profit & Loss Statement

VEC's Profit and Loss Statement is not disclosed.

(ii) Technical aspect

VEC and JAPANESE COMPANY made a memorandum of agreement on exchanging people and information, and strengthening relationship between the two entities in November 2007 and JAPANESE COMPANY opened his office in VEC's head office building in November 2008. Since both companies have kept good relationship through holding courses for education and training in Road Management etc.

At the request of VEC, JAPANESE COMPANY organized a working group to study a new scheme for PVCG Expressway project and has continued to do it.

VEC O&M, a 100% subsidiary of VEC, is now in charge of the operation and maintenance of the 23km section between Cau Gie-Ninh Binh opened in 2011. As of January, 2012, total enrollment in VEC is 127 who have already taken educational and training courses. In the final proposal from JAPANESE COMPANY to VEC, it is stipulated that VEC O&M shall be entrusted with operation and maintenance works of expressway so that JAPANESE COMPANY can transfer its technology and know-how to VEC.

2.1.2 Current Status and Government Policies for Expressway Sector

The following Items are pointed out in the fifth Seminar on Expressway in Vietnam (August 2011) for issues of Expressway Sector. Ultimately the issues can be traced to the fact that available Funds (State budget etc.) which Vietnamese Government can invest for Expressway construction are limited.

(a) Total capital source for land acquisition of Expressway projects only covers approx. 60% of the demand to 2020.

(b) The domestic bond market is undeveloped and international bond markets are still affected by the global economic crisis.

(c) As high as approx. 20 % of annual inflation affected investments.

(d) Only a very few expressways are understood to be financially viable, based on current toll level and projected traffic volume. The private sector is unlikely to step in, unless the regulations are changed and financial support system, such as a Viability Gap Funding, is established. A large portion of the capital costs of expressways will continue to require public sector funding.

(e) Most road projects in Vietnam are not built with toll collection as recovery mechanisms. The toll levels for any BOT projects are fixed at a maximum of twice the level of tolls for non-BOT projects; and these are sparingly low to allow investment recovery. There is no clarity on the Government's policy on toll rate adjustments or the mechanisms to put them into effect.

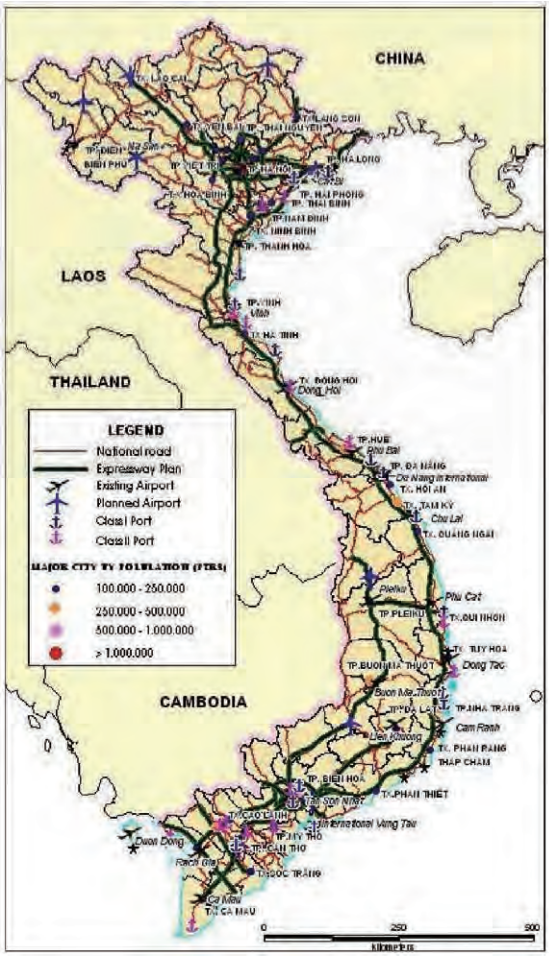
(f) Domestic commercial loans are limited by undeveloped capacity of domestic commercial banks and money markets, and cannot provide long-term capital.

2.1.2.1 Policy on Expressway Development

The Government is considering the BOT scheme based on a Toll Operating Concession with land development rights along the project alignment. Other PPP schemes that are for consideration are the Build-Transfer-&-Operate and the Build-Transfer. These PPP schemes face problems particularly because there are no standard contracts and financing structure that could be used for reference and also because of the inexperience of domestic private investors. The vast majority of road infrastructure BOT project have not been a pure private sector party since the 'Investor' has been a State Owned Enterprise (SOE) or a Joint Stock company with majority shareholding by the SOE's – essentially quasi government corporations.

2.1.2.2 Expressway Master Plan

The Prime Minister approved Expressway M/P (Decision1734/QD-TTg) for 5,873km. Approved expressway network is shown in figure 2.1.2-1.



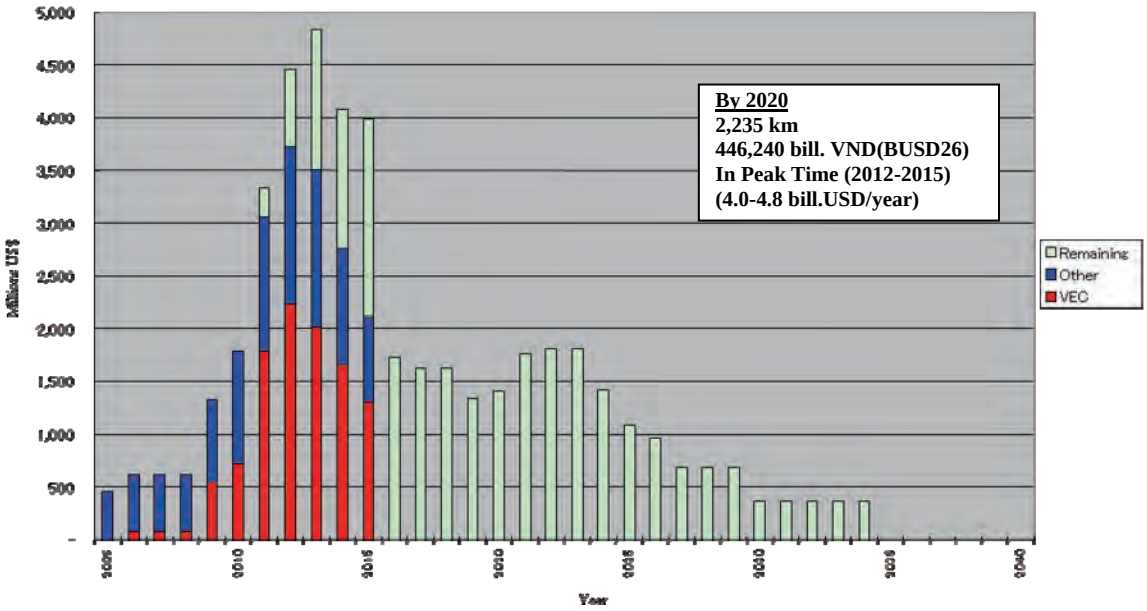
Source：MOT

	Section	Length	Lanes
North – South Expressway			
	East（Phap Van – Can Tho）	1,941Km	4-6
	West（Phu Tho – Pho Chau）	457Km	4-6
	West（Ngoc Hoi – Rach Gia）	864Km	4-6
North Expressway			
	Lang Son – Bac Ninh	130Km	4-6
	Hanoi – Hai Phong	105Km	6
	Hanoi – Lao Cai	264Km	4-6
	Hanoi – Mong Cai	294Km	4-6
	Hanoi – Bac Kan	90Km	4-6
	Hanoi – Hoa Binh	56Km	4-6
	Ninh Binh – Quang Ninh	160Km	4
	Hanoi Ring road No.3	56Km	4-6
	Hanoi Ring road No.4	125Km	6-8
Regional Central and Highland Expressway			
	Hong Linh – Huong Son	34Km	4
	Cam Lo – Lao Bao	70Km	4
	Quy Nhon – Pleiku	160Km	4
Southern Regional Expressway			
	Dau Giay – Da Lat	209Km	4
	Bien Hoa – Vung Tau	76Km	6
	Ho Chi Minh – Chon Thanh	69Km	6-8
	Ho Chi Minh – Moc Bai	55Km	4-6
	Chau Doc – Can Tho	200Km	4
	Ha Tien – Bac Lieu	225Km	4
	Can Tho – Ca Mau	150Km	4
	HCMC Ring road No.3	83Km	6-8
Total		5,873km	-

Figure 2.1.2-1 Expressway Master Plan

2.1.2.3 Capital Requirement for Expressway

Required annual investment for expressway is assumed to be as shown in Figure 2.1.2-2. Annual investment requirement in 2012-2015 is maybe 4.8 billion USD up to 8 times that of the average annual road investment in 2009.



Source："Seminar on Organizational Structure Orientation, Operation Mechanism and Business Development Plans for VEC", VEC, 5th November 2009 Legend: Red—VEC, Blue---Other, Aqua---Remaining

Figure 2.1.2-2 Capital requirement for Expressway Investment

A comparison between investment plan included in VEC seminar in November 2009 and that in Expressway Seminar in August 2011 is shown in the following Table.

Table 2.1.2-1 Comparison of Investment Plan

Description	Issue	Till 2020	After 2020
VEC Seminar	November 2009	A: Target construction length(km) 2,235 B: Necessary Funds (billion US$) 26	A: 3,635 B: 14.5
Expressway Seminar	August 2011	A: Target construction length(km) 1,870 B: Necessary Funds (billion US$) 19	A: 4,000 B: 21.5

Total investment amount for construction the 5,873km expressway network is estimated about 40.5 billion USD. By the year of 2020, total construction expenditure is to be about 19 billion USD for 1,870km and after 2020, to be about 21.5 billion USD for 4,000km. A delay in investment plan is observed compared to plan of 2009.

Up to now only 8 projects are under construction or preparation for construction. These projects are mainly funded by state budget capital, state owned enterprises on lending loan guaranteed by the Government, development investment capital of state owned enterprises and ODA loan. To realize investment on developing whole expressway network, the Government requires involvement of private sector for investment and has been engaged in developing legal system for PPP.

2.1.2.4 Current Status of Expressway Projects

Table 2.1.2-2 and 2.1.2-3 show expressway projects to be constructed by 2020 with status of open, under construction, under preparation of construction and under planning. Lang – Hoa Lac expressway is connecting Hanoi city and Hoa Lac High-tech park; free of charge. At present, HCM – Trung Luong expressway is the only approved toll expressway, however toll collection has not started yet as of September 2011. The investor, BIDV Expressway Development Company (BEDC), acquired a 25-year toll collection right to the HCM – Trung Luong expressway with the toll of 1,000 VND/km.

Table 2.1.2-2 Expressway projects to be completed by 2020

PROJECT NAME w/o Expressway Project	LENGTH (kM)	LANES	TOTAL INVESTMENT (Billion VND)	CONSTRUCTION PERIOD	STATUS
Lang – Hoa Lac	29.5	6	7.527	2005-2010	Completed and open to traffic. By VINACONEX with BT contract
HCM – Trung Luong	39.8	4-8	9.884	2004-2011	Open to traffic. Highly effective. Management by PMU My Thuan.
Cau Gie – Ninh Binh	50	4-6	8.974	2006-2011	Under construction. Management by VEC. Of 50km, 23km has completed. More than18 months behind the schedule. Refer to section 2.3.1.2.
Hanoi – Hai Phong	105	6	24.566	2008-2011	Under construction. Managed by VIDIFI. Late>20 months. Refer to Table 2.1.2-5and Table 2.1.2-6.
Hanoi – Thai Nguyen	62	2-4	8.104	2009-2013	Under construction. Managed by PMU2 -MOT
Noi Bai – Lao Cai	264	2-4	21.233	2010-2014	Under construction. Managed by VEC
HCM – LuongThanh – Dau Giay	54.9	4-6	16.340	2010-2014	Under construction. Managed by VEC
Trung Luong –My Thuan	54	6-8	20.000	200?-201?	In progress Investment by BIDV.
Da Nang – Quang Ngai	139.5	4	27.968	2011-2014	Detailed design about to commence, managed by VEC
Hoa Lac- Hoa Binh	30	6	6.000	2011-2016	In progress investment by Gelecimco
Ben Luc – Long Thanh	57.8	4-6	31.320	2012-2017	Detailed design ongoing, Managed by VEC
Hanoi Ring Road 3rd	56	4-6	17.990	2004-2018	Under construction, managed by PMU Thang Long – MOT

Source: EMO, MOT(Presentation Material for The 5th Expressway Seminar in Vietnam, August ,2011)

Table 2.1.2-3 Expressway projects to be completed by 2020, under study

PROJECT NAME w/o Expressway Project	LENGTH (kM)	LANES	TOTAL INVESTMENT (Billion VND)	CONSTRUCTION PERIOD	STATUS
PROJECTS under Study					
Phap Van – Cau Gie	**28**	**6**	**4.743**	**2012-2014**	**FS study ongoing by NEXCO Central – Japan, JICA (PSIF fund)**
Noi Bai – Ha Longt	196	4-6	20.800	2012-2015	Study investment by GITEC (China)
Dau Giay – Phan Thiet	98.7	4-6	18.388	2013-2016	Study investment by Bitexco. Refer to Table2.1.2-3.
My Thuan – Can Tho	24.5	6-8	15.000	–	Study investment by Cuu Long CIPM. Refer to Table 2.1.2-4.
Bien Hoa – Vung Tau	77.8	4-6	10.026	2013-2017	Investment study by BVEC, already first report study
Hanoi Ring Road No.4	136	6-8	72.000	2011-2020	Preparing investment
Ring Road 3rd - HCMC	90	6-8	43.000	2011-2020	Preparing investment
Ha Long – Mong Cai	130	4	19.000	–	Calling for investment PPP Pilot Project.
Hanoi – Lang Son	158.4	4-6	22.120	–	FS completed. Calling for investment.
Dau Giay – Da Lat	230	4	19.280	–	Calling for investment
Ninh Binh – Thanh Hoa	121	4-6	30.000	–	FS completed. Calling for investment. PPP Pilot Project.
Thanh Hoa – Ha Tinh	160	4-6	24.680	–	FS completed. Calling for investment. PPP Pilot Project.
Cam Lo – Tuy Loan	178	2-4	32.000	–	Calling for investment
Quang Ngai – Quy Nhon	108	4-6	26.654	–	Calling for investment

Source: EMO, MOT(Presentation Material for The 5th Expressway Seminar in Vietnam, August ,2011)

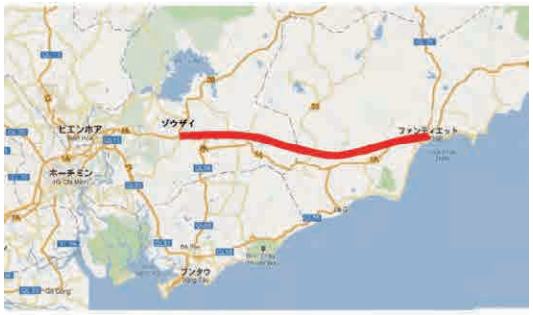
2.1.2.5 Public-Private Partnership (PPP) Expressway Projects in Vietnam

Precedent cases of expressway projects under PPP scheme are shown as below. The Dau Giay – Phan Thiet Expressway is the only 'PPP' project undertaken by the private company.

(1) DauGiay – PhanThiet Expressway

Vietnam government approved Dau Giay-Phan Theit Expressway project as the first PPP project in Vietnam[2]. The outline of the project is as follows:

Table 2.1.2-4 Outline of Dau Giay-Phan Thiet Expressway Project

Name of Project	**DauGiay-Phan Thiet Expressway**
Outline	The Project is important section in Southern Vietnam connecting Phan Thiet city and Dau Giay where it extends to National highway No.1 A . Total length is about 101km with 4 lanes in the 1st phase and 6 lanes in the 2nd phase at road grade A. Design speed is 100km/h- 120km/h There are 9 interchanges, 15 bridges traversing rivers, 19 flyovers and 12 over-bridges. ITS including ETC and traffic management system and service area are to be installed. 
Total Cost	**23.223billion VND** (5 billion VND increased from the previous total cost)
Executing Organization	Originally, investors were decided on No.1169/TTg-KTN dated July, 2010 as follows: The first investor : BITEXCO (Binh Minh Import-Export Co), The second investor: IFC (International Finance Corporation, The third investor : one selected through international competitive bidding However, due to Decision 1495/BGTVT dated July, 2011, they were changed as follows: The first investor: BITEXCO (Binh Minh Import-Export Co), The second investor: one selected through international competitive bidding
Implementing Scheme	As this is the first PPP project in Vietnam financed by WB, the final implementing scheme will be decided after the international consultant selected by WB reviewed it..
Funding	Investment from local and foreign investors. Loan from national budget and World Bank.
Construction Schedule	4 years of construction period after starting in 2012

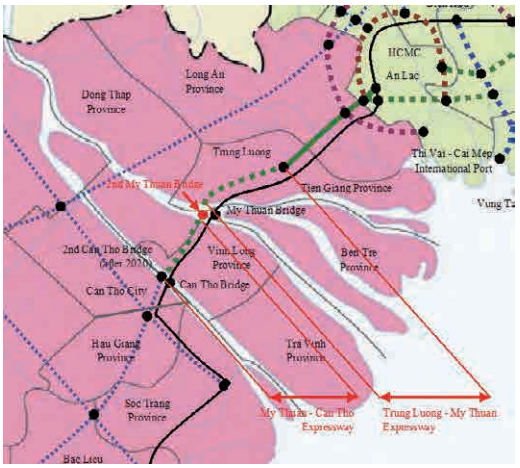
(2) My Thuan-Can Tho Expressway

Together with other Vietnamese corporations, Bank for Investment and Development of Vietnam established BIDV Expressway Development Company (BEDC) and acquired the business right of BOT for Trung Luong-My Thuan-Can Tho Expresway. However, due to the financial difficulty, the section between the second My Thuanb bridge and My Thuan-Can Tho was

[2]Mayer Brown Publications, 10 August 2010, "Vietnam's First Trial PPP Project"

transferred to PMU My Thuan in May, 2009. Latest outline of the Project is as follows:

Table 2.1.2-5 Outline of My Thuan-Can Tho Expressway Project

Name of Project	**My Thuan-Can Tho Expressway**	
Outline	The project is part of Trung Luong~My Thuan~Can Tho Expressway and connects My Thuan City and Can Tho City. About 32.3km of total length with 4 lanes and parking place for emergency at road standard A. Design speed is 100km/h- 120km/h There are 3 interchanges, 17 bridges traversing rivers and 3 over-pass. ITS including ETC and traffic management system and parking area are to be installed.	 source[3]
Total Cost	338 million USD (Of the total amount, it is reportedly said that Prime minister approved 350 billion VND or 18.3 million USD to be invested by the end of 2020)	
Executing Organization	Cuu Long Traffic Infrastructure Investment Development Management Corp (Cuu Long CIPM) under MOT establishes PPP company.	
Implementing Scheme	PPP Implementing agency：PMU My Thuan	
Funding	Using the right to collect toll fees at Can Tho bridge, CIPM invest 30% of total cost (upper limit is 83.35 billion VND). Investment from local and foreign investors. Vietnam government contributes the cost for land acquisition and part of compensation. ADB provide 175 million USD loan and technical assistance. 8 million USD will be disbursed in 2012.	
Construction Schedule	2 years of construction period after starting in 2012. People's committee in Dong Nai province and Binh Thuan province have expressed to undertake land acquisition and relocation of people.[4]	

(3) **Hanoi – Hai Phong Expressway**

Project outline, project scheme, fund procurement is shown in the next page.

[3] Study Report for Preliminary Study on Trung Luong - My Thuan - Can Tho Expressway Construction Project, March 2011, by Engineering and Consulting Firms Association, Japan and Nippon Koei Co., Ltd.

[4] Vietnam Investment Review, 15 November, 2010, "South Getting Connected"

<table>
<tr><td>Project</td><td colspan="3">Hanoi- Hai Phong Expressway</td></tr>
<tr><td>Project Outline</td><td colspan="2">Route:
Hanoi Ring Road No.3 ～ Hung Yen～Hai Duong ～Hai Phong
Road Length 105.5km
6-lane, Road Grade A
Design Speed 120km/h
Road width 100m
Interchange 7
ITS system and closed toll collection system will be introduced. Service area will be constructed.</td><td> 

Route Map</td></tr>
<tr><td>Total Project cost</td><td colspan="3">Approx. 1,722 million USD</td></tr>
<tr><td>Project Company</td><td colspan="3">VIDIFI (Vietnam Infrastructure Development and Finance Investment Joint Stock Company)。
Concession Contract is made with Ministry of Transport (MOT)
In order to compensate low commercial viability, the rights to develop the following:
i) Residential area in Gia Lam and Hanoi city (Total 400ha)
ii) New Urban development in Hai Phong and Hai Duong (150ha)</td></tr>
<tr><td>Project Scheme</td><td colspan="3">BOT (Concession Period 35 years)</td></tr>
<tr><td rowspan="3">Find Procurement</td><td colspan="2">Equity: approx. 250 million USD</td><td>Debt: approx. 1,472 million USD</td></tr>
<tr><td>Share holder</td><td>Ratio</td><td rowspan="2">Contracts Ex-3 and Ex-8 (Total 10 contracts)
Participation of Japanese Banks:
Sumitomo Mitsui Banking Corporation, The Sumitomo Trust & Banking Co.,Ltd , The Bank of Tokyo -Mitsubishi UFJ, Ltd and Citi Bank Japan Ltd
Loan Amount: 270 million USD
(16% of total project costs)
Finance Scheme: Above 4 banks lend US$ for expressway construction to Vietnam Development Bank (VDB) and VDB will VDB lend US$ to VIDIFI, a kind of 2 step loan. For other contracts, VDB and Vietcom Bank are main lenders.</td></tr>
<tr><td>Vietnam Development Bank : VDB
Others (Vietcom Bank Vinaconex, Sai Gon Invetment Group)</td><td>51%
49%
100%</td></tr>
<tr><td>Guarantee</td><td colspan="3">Vietnamese Government and Nippon Export and Investment insurance (NEXI) provide guarantee.
Vietnamese Government (VG) : When VDB is in default, VG unconditionally guarantee to repay the debt.
NEXI : Against Political Risk (restriction/prohibition of exchange dealings, raise in tariffs, restriction/prohibition of imports, acts by a third party other than the party concerned such as war or revolution, or natural disasters and extraordinary events) and Commercial Risk (Borrower, VDB, does not repay the loan) , Overseas United Loan Insurance are provided for 100% of loan amount for 15 years.</td></tr>
</table>

Consultants and Contractors

Contract	Length	Company name	Nationality
Ex-8	10km	Shandong Luqiao Group Co., Ltd	P.R. China
Ex-6	8.7km	GS Engineering & Construction Corporation	S. Korea
Ex-5	15.3km	- China Guangdong Provincial Changda Highway Engineering Co., Ltd - China Guangzhou International Economic and Technical Cooperation Co.	P.R. China
Ex-4	15km	PSJ	Czech
Ex-3	14km:	China Road & Bridge Corporation	P.R. China
Ex-2	12.8km	Namkwang Engineering and Construction Co., Ltd	S. Korea
Construction Supervision		Joint Venture of Meinhardt International Pte Ltd and Japan Engineering Consultants Co., Ltd	Singapore, Japan
Detailed Design		Joint Venture of Yooshin –KPT	S. Korea, Canada

Various source confirmed by MOT

2.1.2.6 Status of Foreign Company in Expressway Project

Figure 2.1.2-3 shows figure of sections by assigned investors and list of foreign companies implementing expressway projects, especially Hanoi – Hai phong, Noi Bai – Lao Cai, HCM – Long Than – Dau Giay expressways as they have many packages conducted by foreign companies. As shown in Table 2.1.2-, a lot of construction companies from South Korea and P. R. China.

Table 2.1.2-6 Presence of Foreign Companies in Expressway construction

Pro-ject	Package	Length	Contractor	Nation
Noi Bai – Lao Cai	1,2 & 3	48.7km	Posco E&C	S. Korea
	4 & 5	102.1km	Keangnam Enterprises Co., Ltd.	S. Korea
	6	39.5km	Doosan	S. Korea
	7	27.6km	Guangxi RBEC	P.R. China
	SV		Getinsa	Spain
	DD (TA, ADB)		PCI PCI Asia Apeco Hafico Groupe	Japan Philippines Vietnam Vietnam
HCM – Long – Dau Giay	1A	3.5km	China Road and Bridge Corp	P.R. China
	3	9.8km	Posco E&C	S. Korea
	5	3.9km:	Pumyang Construction Co., Ltd Sungjee Construction Co., Ltd	S. Korea
	6	17.1km of traffic road	Hashin Construction Co.	S. Korea
	SV(HCMC - Long Than)		Wilbur Smith Associates	USA
	SV (Long Than – Dau Giay)		Nippon Koei TEDI South	Japan Vietnam
	DD		Nippon Koei Hafico Groupe	Japan Vietnam

Various source confirmed by MOT

To see the investment plan, Dau Giay – Lien Khuong and Noibai – Halong expressway are listed. For Dau Giay – Lien Khuong expressway, South Korea's Incheon Urban Development

Corporation (IUDC) made a memorandum of understanding (MOU) with MOT for investment approx. 1 billion USD and plans to build and operate under BOT scheme.
For Noibai – Halong expressway, Economic and Technical Cooperation International Art Guangxi (GITEC) is conducting Feasibility study.

2.1.2.7 Position of the Project

The PV-CG section is located at the starting of the North-South Expressway, the project is to upgrade Bypass of National Route 1 currently in service; opening in 2002, four-lane, toll free; to the expressway standards and further widen to six lanes.
Road sector project priority list attached to the Prime Minister decision No. 05/2011/QD-TTg; Approval of the Transport Infrastructure Projects in Northern Economic Area issued on 24 January 2011, shows PC-CG Expressway (32.3km, 6 lanes).
In April 2011, the right of implement the Project was granted to VEC by MOT. Because of this fact, it is judged that neither New BOT Law nor PPP Piloting Regulation is applicable, because both Law and Regulations require tendering of right to implement the project. This Project will implement under the right granted to VEC and explore a new scheme of cooperation of Public Sector and Private Sector, respecting the intent of both Law and Regulations. If necessary, application for the Prime Minister's approval will be made.

2.2 Current Status and Future Prospects of Project-related Legislation in Vietnam

2.2.1 Legal Aspect regarding PPP

Decree 108 was taken effect on 15 January 2010. Degree 108 superseded Decree 78 that was issued in 2007. Regulation on Public-Private Partnership Investment Piloting (hereinafter referred to PPP Regulation) was issued on 9 November 2010 and it was enforced on January 15, 2011.

(1) Decision No. 71/2010/QD-TTg (PPP Piloting Regulation)

PPP Regulation is temporary regulation for making the Decree while 3 years or 5 years. Article 52 .2 includes the following provision.

> *"Matters not specified in this Regulation must comply with current law and international practices under the Prime Minister's decisions."*

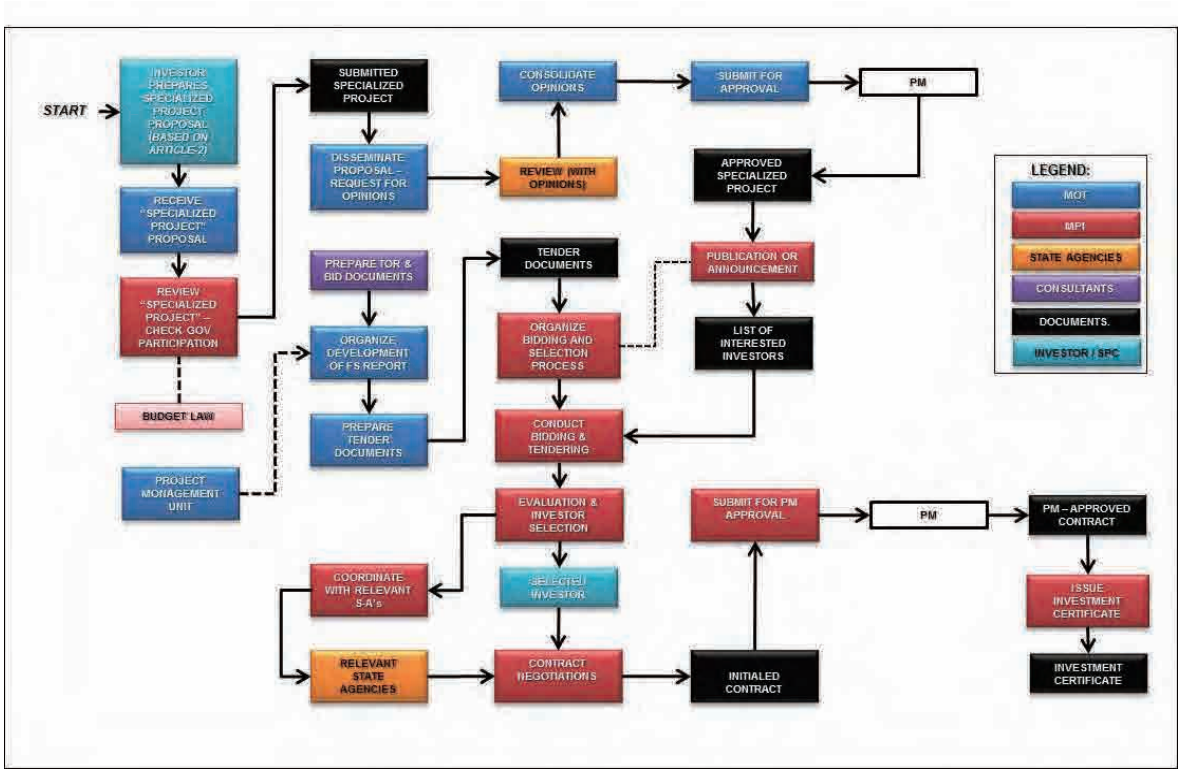
The following table summarizes characteristic points of this regulation.

Table 2.2.1-1 Characteristic points of PPP Regulation

Item	Characteristic
Competitive Bidding of Investors (Concession right)	• Under the regulation, investors are elected by the bid. It is different from decree 108. Schedules are prescribed by the regulation. For example, after the election, the negotiations for right of investment are performed within 30 days, and details contents of the contract are agreed. It is pointed out that these schedules are too short for negotiation from international standard.
State Contribution	• Investments from the state are decreased from 49% to 30%, except for

Item	Characteristic
	exceptionally indication from government.
Equity capital	• It is prescribed that private investment share should be more than 30% and loan share should be under 70%. It is international custom that private investment share is from 10% to 15%.
Investment Incentives	• It is prescribed that reduction of corporation tax, reduction of tariff, and exemption from fixed property tax. Foreign contractor is exempted from some taxation under the low.
Selection of contractor	• Project Enterprise (SPC) has to select the contractor in accordance with Laws and Regulations
Land acquisition	• The Provincial People's Committee expropriates the land, under the project contract.
Security	• Project companies are permitted to pledge or mortgage assets and land use rights in accordance with Vietnam's laws, subject to the consent of the authorized state body and provided that any such pledge or mortgage must not "adversely affect the objectives, implementation progress and operations of the Project".
Exchange Risk	• Project enterprise and investor are given license to exchange VND to foreign currency for the project accomplishment and to send profit to foreign country, under the law.

Following Figure shows project procedure for proposal and contract.



Source : METI FS

Figure 2.2.1-1 The project procedure for proposal and contract (PPP Regulation)

Project outline nominated for pilot project under PPP Regulation is shown in next page. Projects drew a line under its name show that they are among 9 priority ones in the total 24 pilot projects.

Table 2.2.1-2 Outline of pilot projects under PPP Regulation

Projects	Preliminary Information
Highway Ninh Binh – Thanh Hoa	About 126,7km long with 6 lanes, the road passes Ninh Binh, Nam Dinh and Thanh Hoa provinces. The total investment is VND 33,000 billion. MOT approved the final report and project proposal is expected to be submitted in 2011. The WB is taking procedures for raising fund from The Public Private Infrastructure Advisory Fund (PPIAF) do the FS for the Ninh Bình- Thanh Hóa-Bãi Vot Highway Project under PPP form.
Highway Dau Giay – Lien Khuong	This is a category A-highway with designed speed 80-120km/h, about 200km long with 4 lanes. The road passes Dong Nai and Lam Dong provinces. The investment for the project is VND 48,324 billion. MOT approved interim report and its proposal is expected to be approved in 2011.
Highway Ha Long – Mong Cai	This is a category A-highway with designed speed 80-120km/h, about 128km long with 4-6 lanes. The road locates in Quang Ninh province. The investment for the projects is about VND 25,000 billion. At this moment, a technical assistance project has been carried out to set up investment project. MOT approved interim report of Technical Assistance Project.
Highway Ben Luc – Hop Phuoc	This is an urban highway with designed speed 80-100km/h, about 25km long with 4-6 lanes. The road connects Long An province and Ho Chi Minh City. Investment for the project is about VND 15,000 billion. MOT is studying the project and have already approved the initial report.
Highway Nghi Son (Thanh Hoa) – Bai Vot (Ha Tinh)	This is a category A- highway with designed speed 100-120km/h, about 93km long with 4-6 lanes. Investment is about VND 23,000 billion. MOT approved interim report and project proposal is expected to be approved in 2011. The WB is taking procedures for raising the fund from The Public Private Infrastructure Advisory Fund (PPIAF) to do the FS for the Ninh Bình- Thanh Hóa-Bãi Vot Highway Project under the PPP form.
Ho Chi Minh Highway, Cam Lo – La Son Section	This is a category B-highway, designed speed 80km/h, 103km with 4 lanes (2 lanes to be completed first), It locates in Quang Tri and Thua Thien Hue provinces. Investment is about VND 16,000 billion. MOT is studying the project and its approval is expected to be made in 2011.

(2) **Decree 108/2009/ND-CP (New BOT Law)**

On 27 November 2009, Decree 108/2009/ND-CP (Decree 108) was issued. Decree 108 superseded Decree 78/2007/ND-CP (Decree 78) and became effective from 15 January 2010. Decree78 contained key investor incentives and was implemented with the aim of providing a uniform

framework applicable to both Vietnamese and foreign investor.

There were notable revisions of Decree 78 that were addressed in Decree 108.

- Decree 108 continues to retain the 10% equity requirement for projects with investment capital greater than or equal to VND1,500 billion for the portion in excess of the threshold. It also stipulates a required equity ratio equal to 15 per cent in respect of the amount under VND1,500 billion. This would result in an increased overall equity requirement for large-scale projects compared to the position under Decree 78. The 30% equity requirement for projects under VND75 billion has been eliminated. Decree 108 now stipulates a 15 percent equity requirement for all projects under VND1,500 billion.

- Decree 108 specifies that the state-owned capital used to carry out a project must not exceed 4% of the "total investment capital" (comprising debt plus equity), of such project, whereas Decree No. 78 specified a limit of 49 per cent or less of the "required equity" of the investor. This potentially allows the state a greater participation in a project.

- Decree108 stipulates that ministries and local people's committees must make an annual announcement, on January 1, of the list of potential projects which require investment. This announcement must appear in three consecutive issues of the bidding process. Decree No. 108 limits a time to be 30 days from the last issued announcement published for investors to register their interest in certain projects.

- Both Decree 78 and Decree 108 force bidding for projects which are registered for implementation by two or more investors. However, both decrees also contain exceptions to this rule, where an investor may be appointed by the relevant authority without a competitive bid. Significantly, under Decree 108, any project proposed by an investor must in general be publicly tendered out.

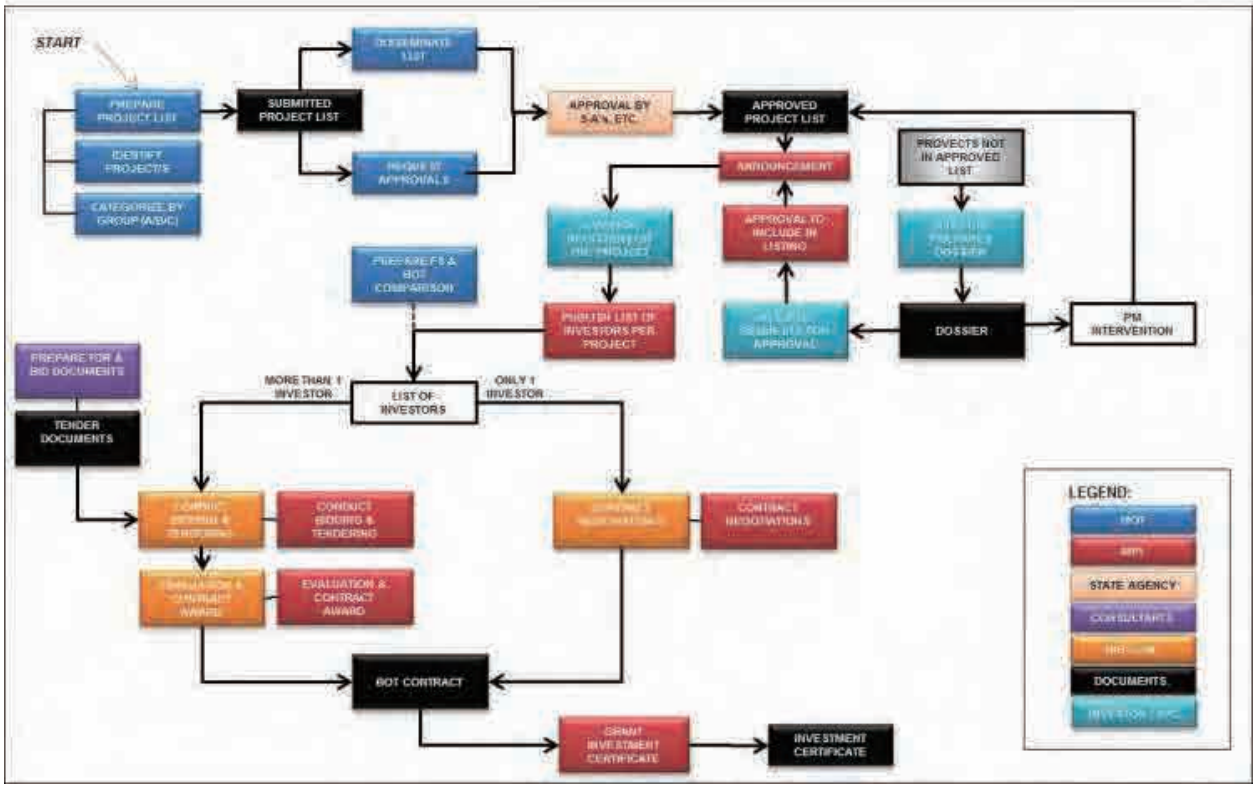
- Under Decree 108, the MPI is clearly authorized to issue investment certificates for projects of "national importance", projects for which a ministry, branch or a body delegated with authority by such ministry or branch is the authorized state body to enter into the project contract and projects which are to be implemented on an area covering a number of provinces or cities under central authority.

- Under Decree 108, all other projects must be licensed by the local people's committees. Investors are required to post a guarantee or security in respect of project performance. The amount of the security depends on the total invested capital of the relevant project. Under Decree108, a 2 per cent minimum deposit/guarantee is required for projects with investment capital equal to or less than VND1,500 billion. For projects with investment capital greater than VND1,500 billion, 1 per cent is required for the amount above VND1,500 billion and 2 per cent is required for the portion under VND1,500 billion.

- Decree108 provides generally that Corporate Income Tax (CIT) incentives for BOT, BTO

and BT projects are in accordance with the "applicable CIT regulations". This provides, for most infrastructure projects, that the 10 per cent preferential rate is available for only 15 years of operation. In addition, the CIT regulations state that the tax exemption and reductions will be applied from the fourth year of operation regardless of the project's profitability at that time.

Figure in the next page shows the process undertaken from Project Listing (by MPI) to Contract, under Decree 108.



Source: METI FS

Figure 2.2.1-2 Process: From Project Listing to Contract – Decree 108 (New BOT Law)

(3) Decree No.12/2009/ND-CP (On Management of Investment Projects on the Construction Works)

Decree No.12/2009/ND-CP was issued on 12 February 2009 and it superseded Decree No.16/2005/ND-CP and No.112/2006/ND-CP. It was taken effect on 2 April 2009. This Decree specifies the following:

(i) Depending on the charcteristic and scale of the project, the projects categorised as Group A, B and C. Group A is large. Authority who evaluates and approve Feasibility Study is specified. Some projects in Group A requires an approval of the Prime Minister.

(ii) Feasibility Study includes Basic Design and Environmental Impact Assessment (EIA) etc. (Article 6,7 and 8)

(iii) The evaluation of Basic Design shall be conducted simultaneously with but not separately from the evaluation of Feasibility Study (an investment project)

(4) **Decree No.29/2011/ND-CP (Providing Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment)**

Decree No.29/2011/ND-CP was issued on 18 April 2011 and it superseded a part of Decree No.80/2006/ND-CP and No.21/2008/ND-CP. It was taken effect on 5 June 2009. Previous Decree No.21/2008/ND-CP requires EIA only for the projects in the length not less than 50 km for upgrading or improving Expressway or Grade I, II or III of Highway. Decree No.29/2011/ND-CP, however, specifies that upgrading or improving Expressway or Grade I, II or III of Highway requires EIA irrespective of its length.

2.2.2 Toll Collection

A present flow of toll collection from planning to execution is as follows:

The Toll Collection Regime calls for the MOF to provide an operator with a set of Toll Reference Rates – the established precedent rates. The operator takes account of these reference rates and submits its Toll Collection Plan to be approved by the MOF. Once the operator-submitted Toll Collection Plan is approved by MOF, this is relayed to the Treasury and the Tickets (Couc Duong Bo) are printed and released to the operator. The operator then sells the Tickets to the Users at the Toll Selling Stations[5].

The User pays the toll by surrendering the Ticket to the toll collector who in turn sends the collected Tickets to the operator office. The operator reconciles and transfers the cash to the Treasury and finally endorses it to the MOF for disbursement to the operator after reconciliations with the operator collection accounts.

Currently, there is no regulation or law concerning toll collection for expressways in Vietnam; however, there are some existing regulations on charges and fees for toll roads:

(i) Ordinance on charges and fees No. 38/2001/PL-UBTVQH10 of August 28, 2001

(ii) Decree No. 57/2002/ND-CP of June 3, 2002 stipulating details in the implementation of the ordinance on charges and fees

(iii) Decree No. 24/2006/ND-CP of the Government on amendment and supplement to some articles of Decree No. 57/2002/ND-CP of the Government dated 03/06/2002 providing in detail the implementation of the Ordinance of Fees and Charges

(iv) Circular No 109/ 2002/TT-BTC of December 6, 2002 guiding the regime of collection, remittance, management and use of road tolls

(v) Circular No. 90/2004/TT-BTC of September 7, 2004 guiding the regime of collection, remittance, management and use of road tolls (replaces Circular No.

[5] At present, common Toll Selling Stations are the operative mode. However, this could be modified for the Private Enterprise (Sector) to have its Toll Selling Stations for its exclusive use.

109/2002/TT-BTC)

With this Circular No.90/2004/TT-BTC, Ministry of Finance stipulates the regulations on the charging and collection of tolls; and the payment, management and use of the collected tolls. It consists of 5 parts: (i) General Provision, (ii) Collection Level and Toll Management and Use Applicable to Each Kind of Road, (iii) Toll Collection Vouchers and Responsibilities of Road Toll Collecting Organizations, (iv) Handling of Violations, (v) Organization of Implementation, and the toll rate table for each vehicle type as Appendix

Some of the key points are as follows:

(i) Toll rates for roads invested with state budget capital shall uniformly apply to all toll booths according to the toll rate table attached to the Circular (refer to Table 3.1.3-3)

(ii) The par value of the single-trip ticket for a car under 12 seats is 10,000 VND per trip.

(iii) The minimum distance between two toll booths on a successive road must be 70 km or longer

(iv) The toll rates for roads invested for business (including BOT and other forms of business) shall not exceed twice the rates applicable to roads invested with state budget capital.

(v) Toll collection companies shall be entitled to deduct part of the collected toll amounts in percentages before remitting them to the state budget

(vi) Toll collection companies may deduct 20% of the collected toll amounts, 5% of which shall be paid to Vietnam Road Administration to invest in the modernization of toll-collection technology. The remaining 15% shall be used to cover the expenses required for toll collection operations.

Table 2.2.2-1 Toll Rate Table by Vehicle Type

Class	Vehicle Type	Toll Rate (VND/Trip)
1	Two wheelers, three wheelers	1,000
2	Tractors	4,000
3	Cars under 12 seats, trucks of a tonnage of under 2 tons, and mass transit buses	10,000
4	Cars with 12 to 30 seats, trucks of a tonnage of 2 to 4 tons	15,000
5	Cars with over 30 seats, trucks of a tonnage of 4 to 10 tons	22,000
6	Trucks of 10 to 18 tons, and 20ft container lorries	40,000
7	Trucks of over 18tons, and 40ft container lorries	80,000

Source: Circular 90/2004/TT-BTC, as of September 7 2004, Guiding the Regime of Road Toll Collection, Payment, Management and Use, MOF.

2.2.3 Legal and Financial Constraints

This project is based on the right to improve, construct and operate PV-CG Expressway granted

to VEC by MOT in April 2010 and a new scheme in which public sector and private sector shares risks is explored. Because the right has been granted to VEC, neither new BOT law nor PPP Piloting Regulation governs this Project. Project Implementation is to be carried out based on a new scheme under the Prime Minister's Decision in the same way as Hanoi-Hai Phong Expressway project which is currently under construction based on the Prime Minister's Decision No.1621/QD-TTg. (Implementation procedures will be decided by the report which will be submitted by MOT to the Prime Minister.)

(1) **Legal Constraints**

(a) As stated above, neither new BOT law nor PPP Piloting Regulation governs this Project. These two law and regulation do not impose direct limitations to the Project. However it is necessary to respect the intent of these two law and regulation and, where applicable, to preserve the intent of them.

(b) PPP Piloting regulation stipulates that the total value of the State contribution shall not exceed 30% of the total project investment except otherwise decided by the Government. In the light of the above stipulation, VEC's investment amount and method to the SPC and the costs of land acquisition, resettlement and compensation should be carefully studied.

(c) By the regulation, the tolls collected at the toll roads in Vietnam should be delivered to MOF before distribution. Whether or not it is possible to simplify and expedite the money flow from road users to the SPC should be examined.

(d) The toll rates for roads invested for business (including BOT and other forms of business) shall not exceed twice the rates applicable to roads invested with state budget capital. Despite as high as approx. 20% of inflation experienced in 2011, no revision is made regarding upper limit of tolls. As a minimum, it is necessary to agree a mechanism to revise tolls linked to inflation rates experienced in the previous period.

(e) According the Vietnamese regulations, the Basic Design for the large infrastructure projects, should be approved by the Prime Minister, for which their EIA should have been approved by MONRE's (or DONRE's) in advance. Without those approvals, the procedures including land acquisition and detailed design cannot be commenced. Since it is a time-consuming process, it is recommended that required procedures shall be practiced soonest possible.

(2) **Financial Constraints**

(a) At the macro level, the amount of Vietnam's public debt has exceeded 50% of GDP and is nearing to 60%. It is required to formulate the project without increasing public debt of Vietnamese Government.

(b) Under such financial situations, the MPI has consistently stated that viability gap funding or other forms of guarantees from the Government would be available for PPP pilot projects only in exceptional cases.[6]

(c) Conversion Risk is considerable risk for foreign investors from financial point of view. Inflation rate (CPI) in Vietnam in 2011 experienced as high as approx.20% compared to 2010. The tendency in which currency depreciation of Vietnam Dong against Japanese Yen continues. The same tendency is observed in other currency, such as US Dollar and Euro. Hedge of conversion risk is big issue and big financial constraint in case equity and debt is

[6] PPP Update: "Forget about past experience", Hogan Lovells, June 2011

provided in Japanese Yen or Yen-denominated base.

2.3 Situation and Trend of Foreign Companies, Current Status in Project Areas

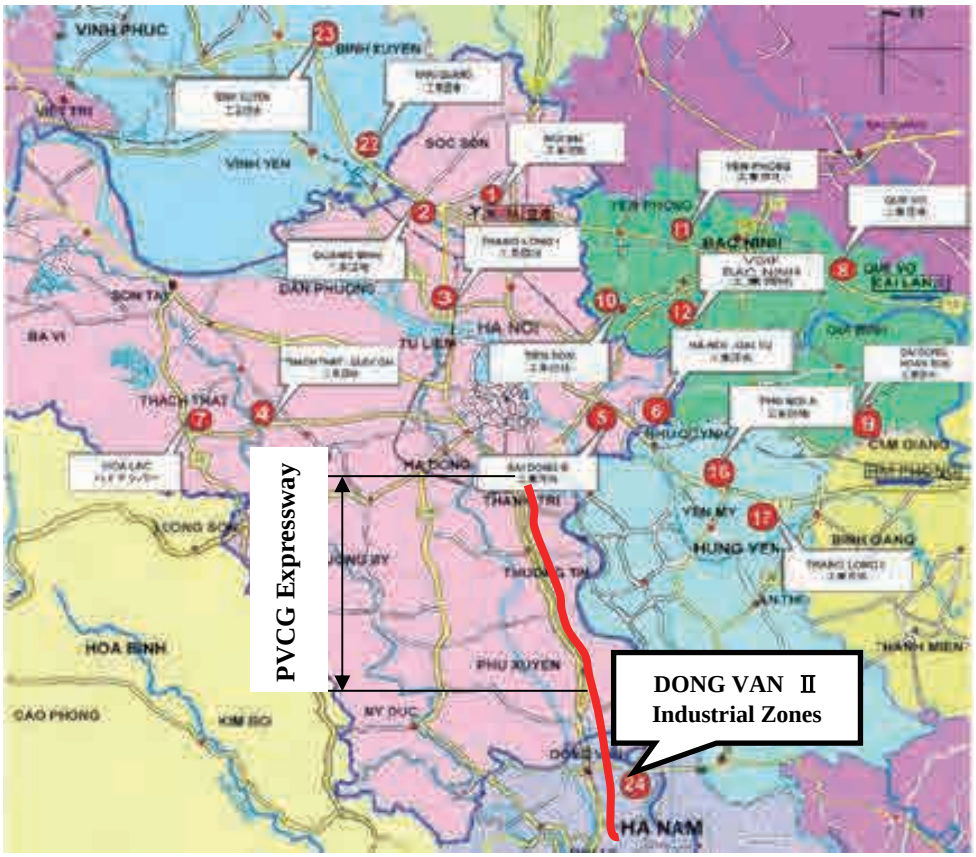
2.3.1 Outlines of the Project Area

2.3.1.1 Project Area

The location of industrial zones in Hanoi are Shown in the following Figure. Industrial zones are situated mainly along the main roads for highly convenient.

Major arterial road	Explanation
Than long－Noi bai	The highway linking Hanoi city (Thang Long bridge) and Noi Bai Airport.
Highway No.5	The highway linking Hanoi city and Hai Phong city.
Highway No.18	The highway linking Hanoi city (NoiBai Airport) and Cai Lan Port.

There is Dong Van II Industrial Zone (7 Lots out of total 11 Lots are Japanese-owned-companies which handle rare earth, motor bike parts, electronic parts, etc. for Exporting) in the south of PVCG highway. Therefore, future development along the “PVCG Expressway” as well as other industrial park is expected.



Source: Data Collection of Industrial Zone among south and middle Vietnam from JETRO

Figure 2.3.1-1 Location of Industrial Zones

2.3.1.2 Cau Gie - Ninh Binh Expressway

The Cau Gie–Ninh Binh Expressway is the first expressway that VEC has responsibility from construction to operation and maintenance. 56km long expressway is under construction. In the first phase, 4 lane expressway with 6 lane sub-grade will be constructed and carriageway will be

widen to 6 lanes in the second phase.

Total construction cost is estimated to be 8.9 trillion VND and funding sources are VEC's equity and Government Guaranteed Bond.

As of September 2011, 20km is completed. It is scheduled to partially open on November 2011. Progress of implementation is behind the schedule, however, 1.7 trillion VND project bond guaranteed by Government is approved by the Prime Minister, in addition to 5 trillion VND which has been approved by September 2011. Next year, remaining 2.2 trillion VND will be invested and expected to be fully open to traffic on September 2012.

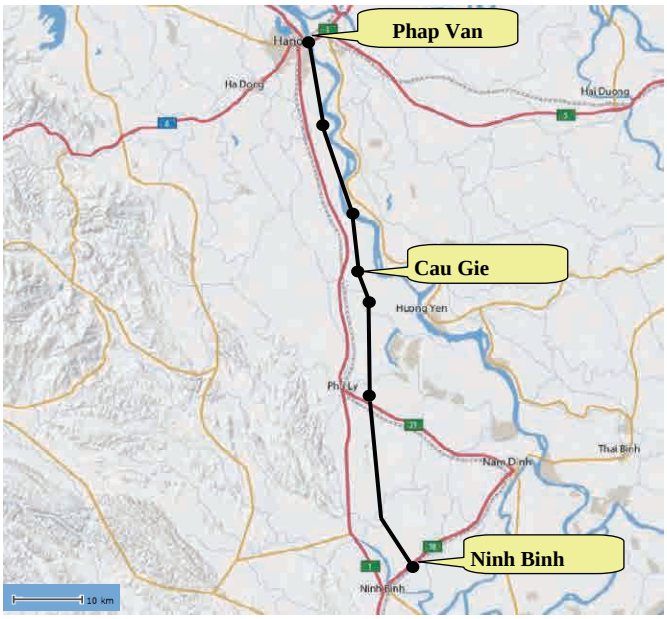
Basic design of Intelligent Transport System (ITS) on Cau Gie – Ninh Binh expressway was conducted by joint venture of CADPRO (Vietnam) and Guangxi (China), with technical review by Korean Expressway Corporation (KEC). After the completion of Basic design, MOT issued the letter to relevant agencies to apply RFID passive 860-960Mhz according to Standard ISO/IEC 18000-6C, generation 2 for no-stop automatic toll collection system for expressway project in Vietnam. Following that letter, CADPRO revised and resubmitted the basic design of ITS to MOT and it was approved. Detailed design was conducted by CADPRO and under examination at present. The ITS system applied to Cau Gie – Ninh Binh is also applied to PV-CG.

Table 2.3.1-1 Traffic Forecast of Cau Gie – Ninh Binh

Unit: PCU/day

Year	Cau Gie-Phu Ly	Phu Ly- Ninh Binh
2012	12,830	9,875
2015	24,293	20,184
2020	53,389	48,594
2025	87,034	82,621
2030	121,825	116,949

Source: August 2011 VEC HP (http://123.30.183.233:8080/popup.aspx/en/66/0/cid=330/nid/tempid=1）



Source：Study Team

Figure 2.3.1-2 Route from Phap Van to Ninh Binh

Table 2.3.1-2 Traffic Forecast of Phap Van– Cau Gie(VEC)

Unit: PCU/day

Year	Phap Van– Cau Gie	Remark
2015	19,802	Toll fee is 1,000VND/Km
2020	25,380	
2024	30,271	

Source: October 2011 VEC

Table 2.3.1-3 Traffic Forecast of Phap Van– Cau Gie(Study team)

Unit: PCU/day

Year	Phap Van– Cau Gie	Remark
2015	34,308（21,785）	Toll fee is 1500VND/km at the time of the year 2012 The value of brackets are vehicles / day
2020	51,434（31,179）	
2024	62,801（36,353）	

Source: Study team

Study team also carried out the Traffic Demand Forecast. The results are shown in Sub-Clause 3.1.2 Traffic Demand Forecasting.

2.4 Necessity of Project

Traffic congestion in Hanoi is getting worse year by year for its growing economy and increasing number of motorcycles and private cars. On March 2010, Hanoi city announced to construct promptly new viaduct roads on the heaviest congested 6 roads, as well as to enforce traffic regulation.

On the other hand, Master Plan of North – South Expressway, which connects Hanoi and Can Tho, was approved by prime minister on 21st January 2010. “PV-CG Expressway”, the starting point of North –South Expressway and the first road in the standard of expressway in Vietnam, is suffering from pavement deteriorations due to traffic loading and ground settlements. Upgrading of existing Highway to “PV-CG Expressway” and widening to 6-lane is required for coping with increasing traffic volumes. According to the traffic forecast of PVCG Expressway, there is 62,801PCU/day in 2024 and it is close to around 90% of 72,533PCU/day which is traffic capacity, so it is dispensable for widening to 6-lane.

Although the project was granted to VEC by Vietnamese Government via MOT in 2010, the project has not been implemented yet because of difficulty of financing.

All these condition indicate that the necessity of project implementation with utilizing private fund efficiently. This Project m

2.5 Basic Principles in the Proposal

This study is formulated based on the following principles:

(1) Early improvement of PV-CG Expressway

At Cau Gie, a gateway to Hanoi, the project connects with Cau Gie-Ninh Binh Expressway where its construction is now undergoing. Thus, it is necessary to improve the Project firmly and timely in consistent with the opening schedule of the said Expressway.

(2) Provision of funds for improvement of other Expressways by maximizing revenue of VEC

Expressways in Vietnam are valuable assets to the country and people. Thus the mechanism that the portion exceeding the reasonable profit corresponding to its investment will be effectively stocked by VEC and used for the improvement of other expressways in Vietnam, shall be built in as part of the Project.

(3) Maximum utilization of Japanese technology and know-how on Expressway operation

Expressway is not only one of the most important social infrastructures for the development of the nation but also requires substantial costs for its operation and maintenance for a longer period of time. Thus, it shall be secured that construction, operation and maintenance of Expressway will be undertaken considering the entire period in future as well as the period during collecting toll fees. Furthermore, by utilizing Japanese technology and know-how at its maximum, Expressway shall be improved and operated highly taking safety aspect into account.

(4) Close cooperation between Japan and Vietnam for Project formulation and implementation

The section to be improved is a part of the North-South Expressway which is one in the three strategic sectors Japan and Vietnam governments agreed to cooperate. Thus, it is significant that relevant Japanese and Vietnamese official institutions and private companies cooperate closely because this section is the most critical gateway to Hanoi.

3. Study and Proposal on Project Implementation Plan

3.1 Traffic Demand Forecasting

3.1.1 Traffic Demand Forecasting

Traffic demand has been estimated in this study according to the existing statistics and the latest data acquired during an onsite study.

(1) Summary

Traffic demand forecast had been estimated in both METI F/S and VEC F/S. There is large difference between traffic volume in METI F/S and traffic volume in VEC F/S, because data and calculation method applied in each existing study were different. OD in METI F/S was based on VITRANSS2 which data contain wide area, and OD in VEC F/S was based on traffic survey result. Thus VEC F/S does not take road network around PV-CG Expressway into account.

The Study Team calculated traffic demand forecast based on OD of METI F/S with revised road network and revised time cost. Following Items (3), (5) and (6) are extracted from METI F/S.

(2) Existing Study

1) METI F/S

The summary of the demand forecasting conducted as part of METI F/S is shown below:

Table 3.1.1-1 Summary of METI F/S's Demand Forecasting

Items	Summary
Zone classification	70 Zones in total (30 zones including the Hanoi City and Noi Bai International Airport; and 40 zones for outside the City, which follows the zones defined in VITRANSS2)
Current OD (Origin-Destination)	The data of interprovincial traffic determined by VITRANSS2 are used. Hanoi City is divided in zones according to the population. Inner-city traffic was determined through the result of interview-based survey.
Future OD	For interprovincial traffic, the OD data from the VITRANSS2 was used. For inner-city traffic, socioeconomic index for 2020 and 2030 was used to forecast the future OD.
Network	Hanoi City Master Plan
Service road	None
Toll rate	800VND/km

2) VEC F/S

The summary of the demand forecasting conducted as part of VEC F/S is shown below:

Table 3.1.1-2 Summary of VEC F/S's Demand Forecasting

Items	Summary
Zone classification	12 Zones in total (5 zones for the Hanoi City and 7 zones outside the City)
Current OD	Interview-based survey or traffic counts were used to determine the current OD data.
Future OD	Socioeconomic index was used to determine the future OD.
Network	Takes account of the current network and the future developments (PV-CG Expressway: 6 lanes, Ho Chi Minh Expressway: 4 lanes, North-South Express Railway, Ring Road No.3, 4, 5)
Service road	2-lane roads in both sides of the expressway will be constructed in parallel. For the purpose of traffic demand forecasting, the traffic volume of the expressway (excl. the service road) will be calculated, then certain percentage of each vehicle type will be assigned to the traffic volume of the service road
Toll rate	Free

3) Comparison of existing studies

The following tables show the comparison of the traffic volume estimates between the METI F/S's calculation and the VEC F/S's calculation (Passenger Car Unit/day). The estimates for Year 2020 or 2030 determined by the METI F/S are 1.1 to 1.2 times or 1.4 times higher respectively than those from VEC F/S.

Table 3.1.1-3 Comparison of Traffic Volume Forecasting for Year 2020

（PCU/day）

Type of vehicle	Phap Van - Thuong Tin		
	VEC FS (a)	METI FS (b)	(b)/(a)
Car	15,493	23,659	1.53
Small Bus	8,335	18,688	0.96
Large Bus	11,152		
Small Truck	9,238	13,653	1.34
Large Truck	929		
Total	45,147	56,000	1.24

Type of vehicle	Thuong Tin – Cau Gie		
	VEC FS (a)	METI FS (b)	(b)/(a)
Car	14,665	11,836	0.81
Small Bus	8,407	15,957	0.80
Large Bus	11,490		
Small Truck	8,434	24,907	1.96
Large Truck	4,288		
Total	47,284	52,700	1.11

Table 3.1.1-4 Comparison of Traffic Volume Forecasting for Year 2030

（PCU/day）

Type of vehicle	Phap Van - Thuong Tin		
	VEC FS (a)	METI FS (b)	(b)/(a)
Car	27,013	29,347	1.09
Small Bus	12,527	17,497	0.64
Large Bus	14,921		
Small Truck	10,709	48,226	4.13
Large Truck	977		
Total	66,147	95,070	1.44

Type of vehicle	Thuong Tin – Cau Gie		
	VEC FS (a)	METI FS (b)	(b)/(a)
Car	28,028	15,159	0.54
Small Bus	13,902	17,340	0.56
Large Bus	17,123		
Small Truck	10,687	73,054	4.92
Large Truck	4,163		
Total	73,903	105,553	1.43

(3) Methodology for Traffic Demand forecast

Traffic demand forecast was done in the following way:

<OD Matrix>

◇ Build the regression model from Socio Economic Indices until 2010 and volume of Generation and Attraction of Passengers and Freight in 2010.

◇ Estimate volume of Generation and Attraction of Passenger and Freight in 2020 and 2030 by Regression model and Socio Economic frame in 2020 and 2030.

◇ Build the Trip Assignment Model based on Generation and Attraction of Passenger and Freight in 2010 and their distribution.

◇ VITRANSS2 was comprehensive transport master plan covering from road, railway, aviation, inland waterway and to seaway. OD matrices developed in VITRANSS2 are passenger based on passenger OD and tonnage based on freight OD. Modal share was considered at the same time. In this regards, Study Team also developed OD based on passenger and OD based on tonnage, respectively, and then calculated OD based on trip by car type from share of car type and average occupancy for passenger car or average of loading for truck.

<Road Network>

◇ Establish road networks in 2020 and 2030 were based on Hanoi City Master Plan[1]

Based on the above, traffic forecast was done by conducting traffic assignment using OD matrices based on VITRANSS2and Networks in 2020 and 2030.

[1] Hanoi Construction Master Plan through 2030 with a Vision towards 2050, Hanoi City, 2010

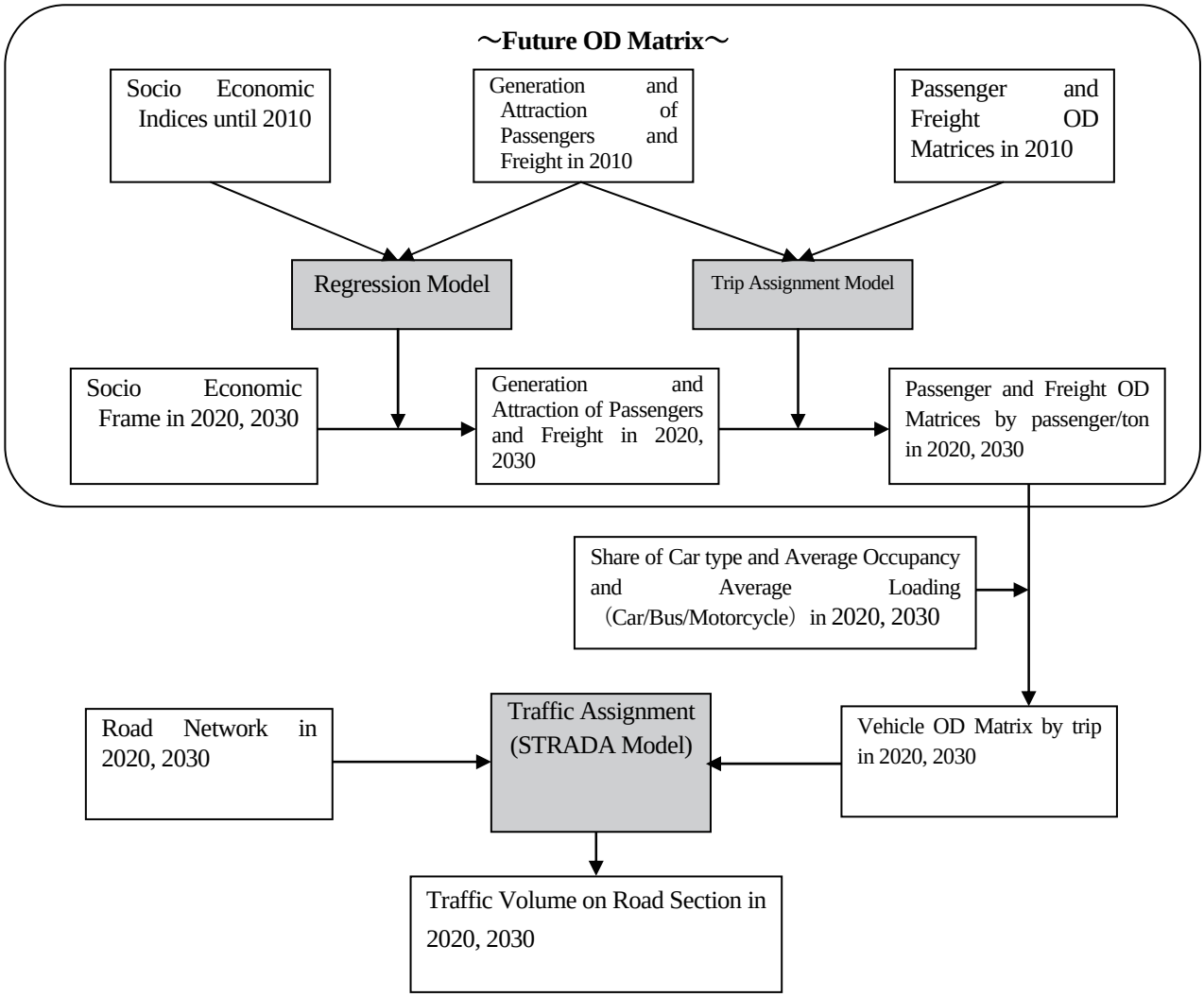


Figure 3.1.1-1 Flow of Estimating Future Traffic Demand Forecast

(4) Zoning

PV- CG is a link originating from the Ring Road 3 of Hanoi going parallel with NH1 and joining with NH1 at Cau Gie. Traffic demand on this road is mainly Interprovincial transport, which is very small and mainly long-distance trips. Cau Gie – Ninh Binh Expressway is under construction and expected to open in 2012. Urban traffic demand includes daily commune trips and short-distance trips using the NH1.

Traffic demand on two future expressways will consist of interprovincial traffic and through traffic of Hanoi and long-distance Inner-provincial traffic. In order to forecast the traffic demand on the expressways, the Study Team divides whole Hanoi city area into 29 traffic zones in accordance with 29 provinces of Hanoi. In Addition the Study Team divides Thanh Tri Province into 2 zones, and Thuong Tin Province into 4 zones, and Phu Xuyen Province into 3 zones. PV-CG Expressway located on these three provinces. As a result, 35 zones were finally studied. Thanh Tri, Thuong Tin and Phu Xuyen are divided accordance with each district. And OD is distributed in proportion to each zone's population.

Table 3.1.1-5 Traffic Zone in Thanh Tri、Thuong Tin、Phu Xuyen

Before divided (Province)	After divided（District）	Population (Person)
Thanh Tri	Van Dien, Dai ang, Huu Hoa, Lien Ninh, Ngoc Hoi, Ta Thanh Oai, Tam Hiep, Tan Trieu, Thanh Liet, Tu Hiep, Vinh Quynh	122,560
	Dong My, Duyen Ha, Ngu Hiep, Van Phuc, Yen My	36,190
Thuong Tin	Thuong Tin, Ha Hoi, Hien Giang, Hoa Binh, Khanh Ha, Nguyen Trai, Nhj Khe, Quat Dong, Tan Minh, Tien Phong, Van Binh, Van Phu	83,284
	Chuong Duong, Duyen Thai, Hong Van, Lien Phuong, Ninh So, Thu Phu, Tu Nhien, Van Tao	55,122
	Dung Tien, Minh Cuong, Nghiem Xuyen, Thang Loi, To Hieu, Van Tu	45,171
	Le Loi, Thong Nhat, Van Diem	18,993
Phu Xuyen	Phu Xuyen, Chau Can, Chuyen My, Dai Thang, Dai Xuyen, Hoang Long, Hong Minh, Phu Tuc, Phu Yen, Phuong Duc, Quang Trung, Son Ha, Tan Dan, Tri Trung, Van Hoang, Van Tu	106,450
	Phu Minh, Hong Thai, Nam Phong, Nam Trieu, Thuy Phu, Van Nhan	29,819
	Bach Ha, Khai Thai, Minh Tan, Phuc Tien, Quang Lang, Tri Thuy,	48,243

Source:

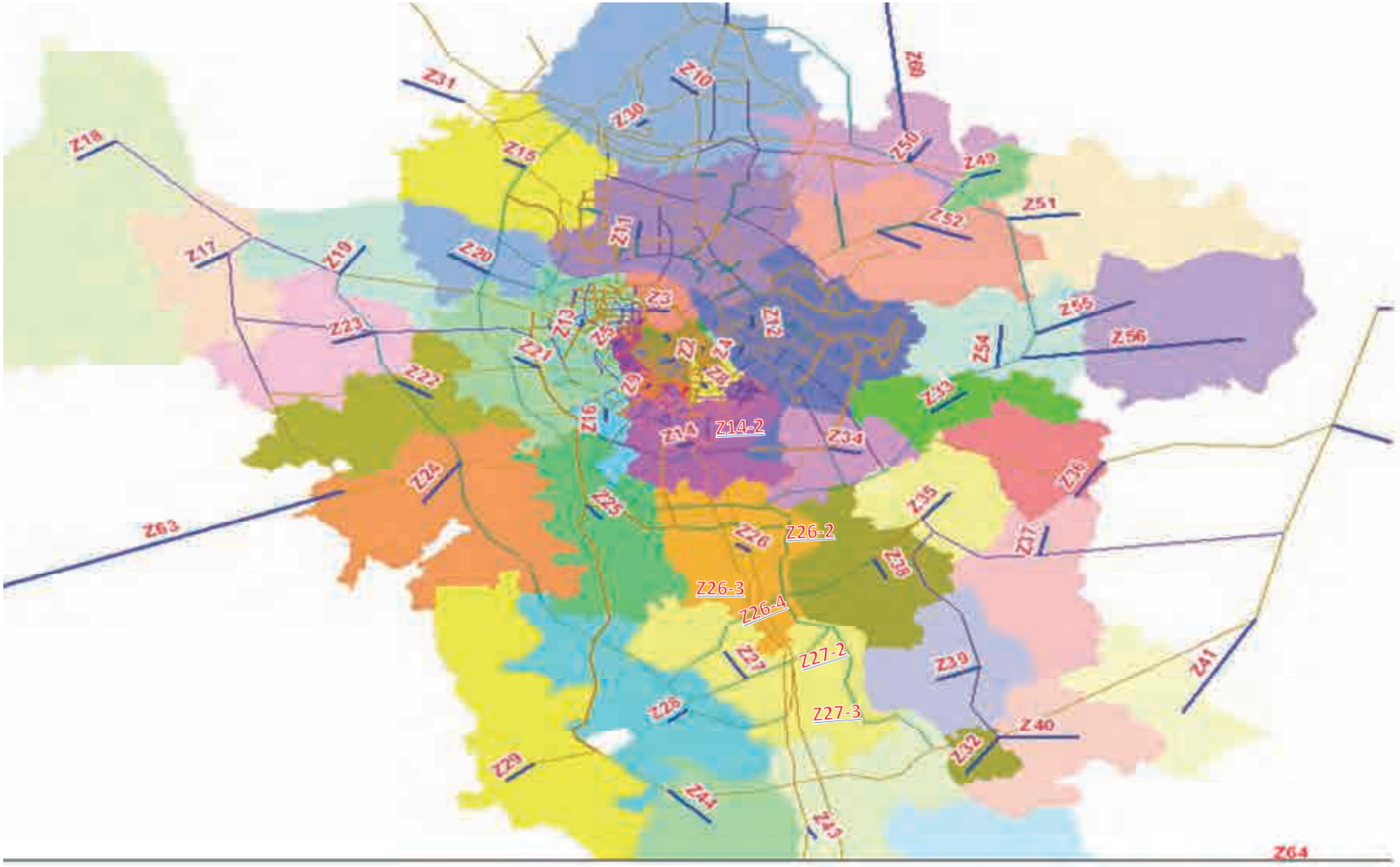


Figure 3.1.1-2 Traffic Zone

(5) Modal Share Settings

According to the transport development plan of Hanoi Capital to 2020, Hanoi will have a railway network with 5 lines, in which line 2 from Noi Bai to the city center is competing against "Mai Dich - Noi Bai". On the other hand, there is no railway line competing against "PV- CG". Therefore, modal share of railway was not set for "PV - CG".

1) Share of Passenger Vehicle

Share of passenger vehicles consisting of passenger car, bus and motorcycle are show in which are applied traffic survey result of locations 7, 9, 11, 13 and 15. Though share of motorcycle is 6.64%, future share had assumption to be decreased gradually.

Table 3.1.1-6 Share of Passenger Vehicle

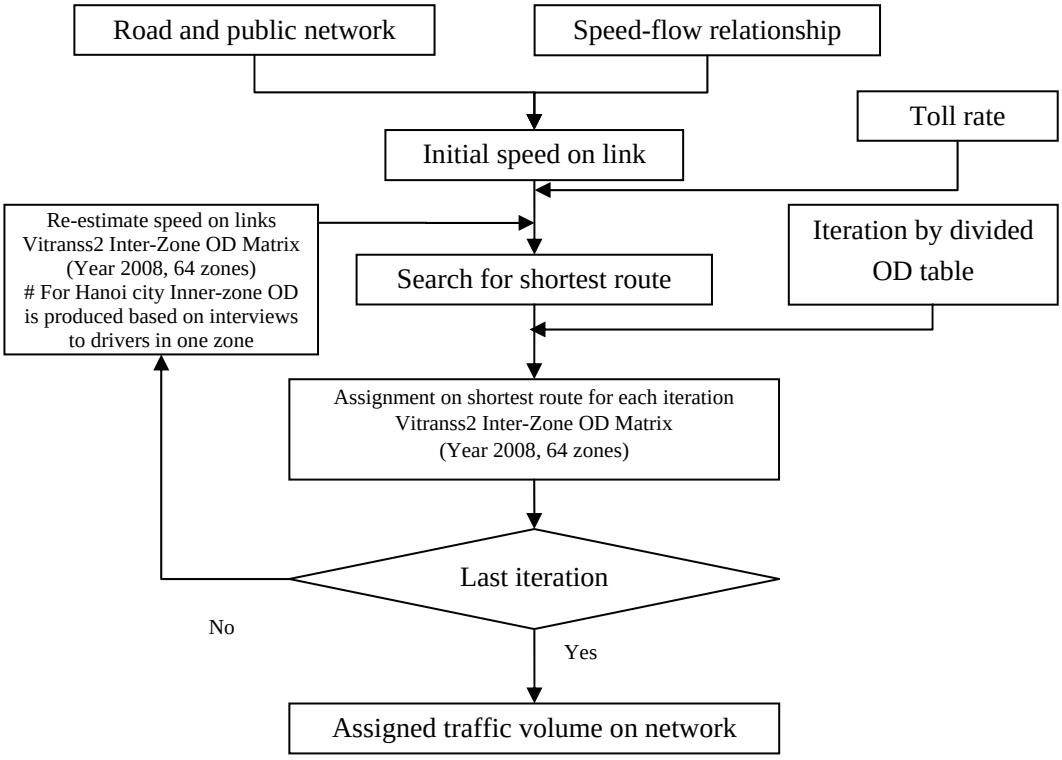
Unit : % of trips/ day

Year	Car	Bus	Motorcycle
2020	48.67%	45.34%	5.99%
2030	53.78%	41.26%	4.96%

Source: Study Team

(6) Conditions of Traffic Demand Forecast

In this study, capacity restraint assignment method, which was the most commonly used in network models, was applied. This assignment technique is based on the speed – flow relationship, and the flow chart of the applied methodology is shown in Figure 3.1.2-3. In this assignment technique, and by calculating the required travel time for each link according to its travel speed and road conditions, the program determines the fastest routes between each origin and destination by evaluating the consuming time on links, and assigns the trips between the given origin and destination to these routes starting to the destination and working back to the origins. As congestion increases till a certain level, alternative routes are introduced to handle the unassigned traffic. Zone-to-zone routing is built, which is the fastest path from each zone to any other, and all trips are assigned to these optimum routes.



Source: METI F/S

Figure 3.1.1-3 Traffic Assignment Flowchart

(7) Road Network

The Study Team make a road network include with Hanoi City Road at east side of PV-CG Expressway, because Hanoi City made construction plan of Hanoi City Road. The Study Team makes plan of frontage road on both side of PV-CG Expressway. But the Study Team is not include this frontage road in the network for traffic demand forecast, because this frontage road will be construct for residents who lived in around PV-CG Expressway and this traffic demand forecast handle long and middle range trip.

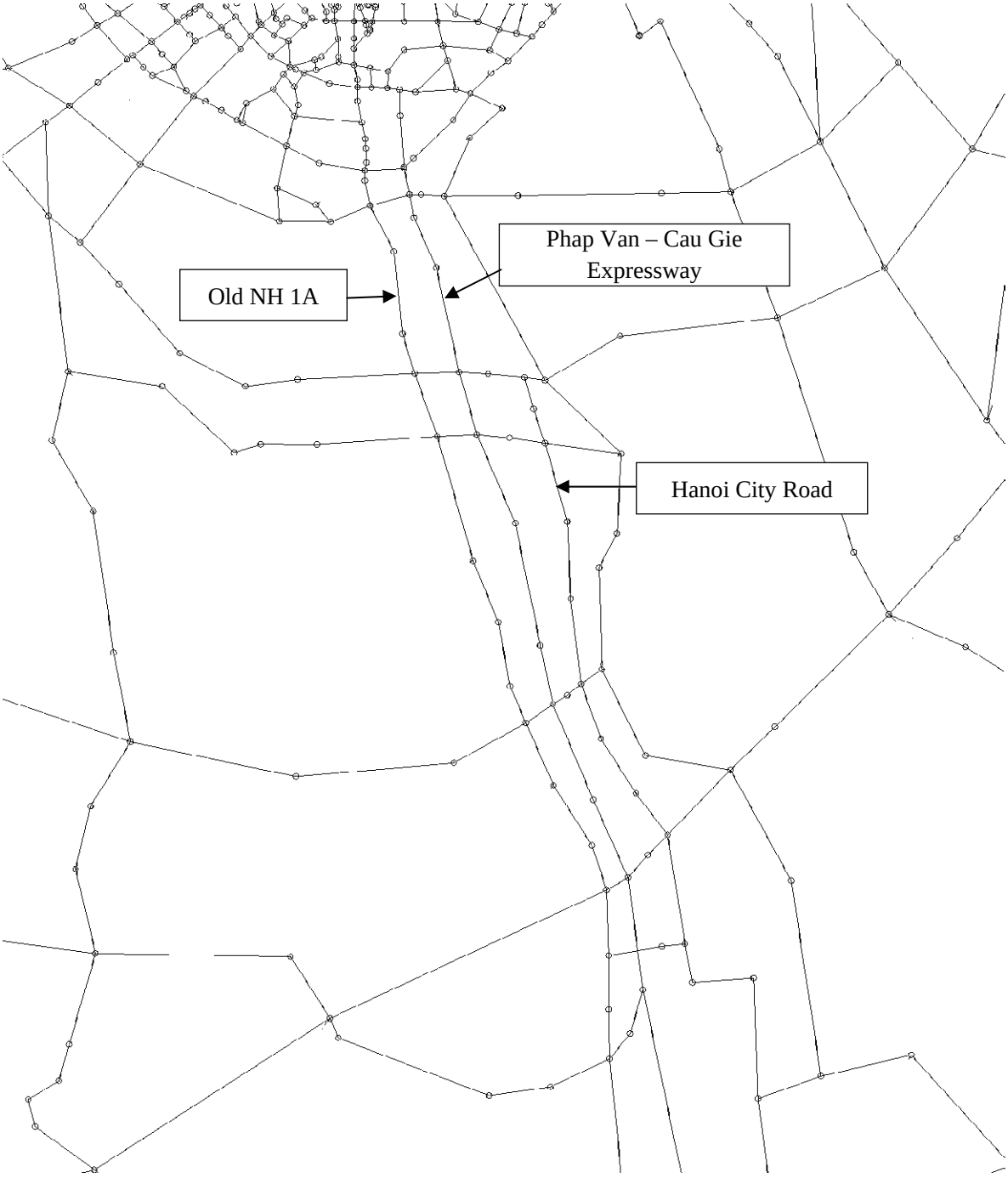


Figure 3.1.1-4 Road Network（2030）

(8) Conversion Factor

Passenger Car Equivalent (PCE) used is as shown in following table.

Table 3.1.1-7 Passenger Car Equivalent（PCE）

Car Type		Composition ratio	PCE	Aggregate PCE
Car/van		100.0%	1.0	1.0
Bus	Bus (≤ 24 seats)	40.0%	2.0	2.3
	Bus (> 24 seats)	60.0%	2.5	
Truck	4-wheel truck	4.5%	1.0	2.4
	2-axle, 6-wheel truck (Medium truck)	59.0%	2.0	
	3-axle truck (Heavy truck)	20.5%	3.0	
	Over 4-axle truck (Trailer)	16.0%	3.5	

(9) Time Evaluation Value

Time evaluation values are set as follows:

◇ Following the methodology applied to F/S on GMS Hanoi-Lang Son Expressway Project (ADB, June 2011)[2]

◇ Car and Bus: Based on time evaluation value used inVITRANSS2, price was updated with annual growth of socio economic framework.

◇ Truck : Applied truck ratio against private car of HOUTRANS, which is Urban transport master plan and FS in Ho Chi Minh

Table 3.1.1-8 Time evaluation Value by Vehicle Type

（unit：USD/h）

Vehicle Type	2010	2020	2030
Car	7.95	13.12	19.98
Bus	27.09	44.51	67.70
Truck	10.77	21.98	33.45

(10) Toll Rate

Toll rate for Expressway is not established in Vietnam. Toll rates are set as follows:

◇ Toll rate of car is set 1000VND/km(Closed toll system is applied)

◇ Toll rate ratio by vehicle type follows existing toll collection system as shown in Table 3.1.1-9. Car type for traffic assignment is 3 (car ,bus and truck) but existing toll collection system has 7 car types, thus, toll rate and traffic volume by 7 car type was weighted average into 3 types.

◇ Commuter ticket is not considered.

◇ Motor cycle is excluded as it is prohibited to run on expressway.

[2] F/S on GMS Hanoi-Lang Son Expressway Project (ADB, June 2011)

Table 3.1.1-9 Toll Rate Ratio

	Car	Bus		Truck			
		Bus≤24 Seats	Bus≥25 Seats	Pick-up & 4WD	Medium Truck	Heavy Truck	Truck & Trailor
Toll Rate Ratio (General Road)	1.0	1.5	2.2	1.0	2.2	4.0	8.0
Traffic volume	100%	40.0%	60.0%	4.5%	59.0%	20.5%	16.0%
Toll Rate Ratio	1.0	1.92		3.44			

（Source：Circular No.90/2004/TT-BTC, as of September 7, 2004, Guiding the Regime of Road Toll Collection, Payment, Management and Use, MOF）

(11) Validation of Present Traffic Assignment

OD in 2010 applied this time was validated whether it has enough reliability as the basis for calculating future OD.

Differences between traffic assignment and traffic Survey result in METI F/S are shown in following table and following figure. As shown in following figure, its result was proved that OD was adequate to become basis of future OD.

Table 3.1.1-10 Difference between Conducted Traffic Survey Result and Assigned Traffic

Location	Road Name	Total PCU in accordance with the counted traffic of two types of bus and dour types of truck	Total PCU assigned on the network	Difference
Location 07	PVCG	27,886	36,038	1.292
Location 09	PVCG	34,114	38,083	1.116
Location 11	PVCG	34,808	33,327	0.957
Location 12	Old NH1	4,917	5,601	1.139
Location 13	PVCG	32,034	33,306	1.040
Location 15	Old NH1	34,414	33,641	0.978

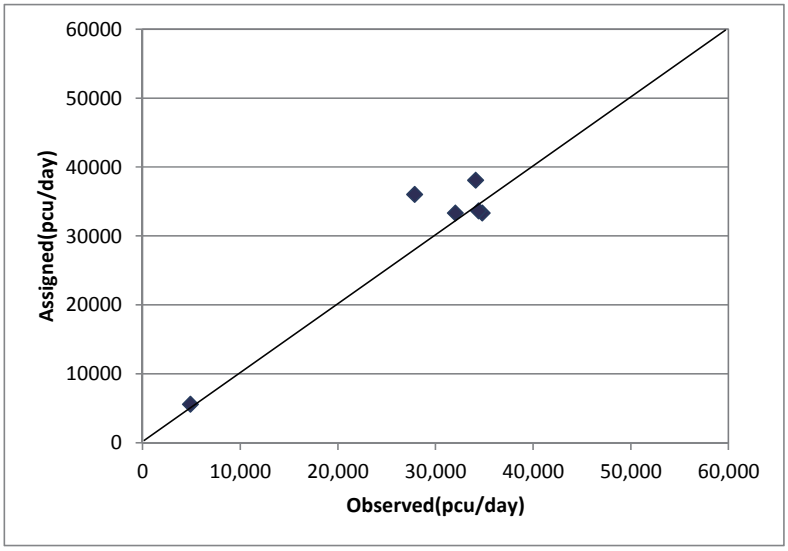


Figure 3.1.1-5 Comparison between Observed and Assigned Traffic at Individual Sites

(12) Traffic Demand

1) Traffic Volume inter IC

Traffic volume in 2020 and 2030 are shown in following table.

Table 3.1.1-11 Traffic Volume of PV– CG Expressway in 2020

unit：PCU/day

			Car	Bus	Truck	Total
Phap Van	～	Thuong Tin	19,725	14,706	19,710	54,140
Thuong Tin	～	Van Diem	20,932	15,723	16,037	52,692
Van Diem	～	Cau Gie	9,834	13,955	24,270	48,058

Table 3.1.1-12 Traffic Volume of PV–CG Expressway in 2030

unit：PCU/day

			Car	Bus	Truck	Total
Phap Van	～	Thuong Tin	22,043	14,675	52,784	89,502
Thuong Tin	～	Van Diem	21,054	16,044	55,829	92,927
Van Diem	～	Cau Gie	12,530	17,912	57,652	88,094

2) Change of future traffic volume

Change of future traffic volume is shown in following table. This traffic volume is calculated by a weighted average distance between the IC.

The Study Team assumed that 4 lanes Expressway will be opened at 2014, and 6 lanes Expressway will be opened at 2020, and project term is 20 years.

Table 3.1.1-13 Change of future traffic volume

unit：vehicle/day

Year	Car	Bus≤24 Seats	Bus≥25 Seats	Pick-up & 4WD	Medium Truck	Heavy Truck	Truck & Trailer	Total
2014	11,875	2,095	3,142	157	2,063	717	559	20,608
2015	12,453	2,163	3,245	177	2,315	804	628	21,785
2016	13,060	2,234	3,351	198	2,598	903	704	23,048
2017	13,696	2,307	3,460	222	2,915	1,013	791	24,404
2018	14,363	2,382	3,574	250	3,272	1,137	887	25,864
2019	15,062	2,460	3,691	280	3,671	1,276	996	27,436
2020	16,256	2,554	3,831	384	5,038	1,750	1,366	31,179
2021	16,436	2,580	3,870	424	5,565	1,934	1,509	32,318
2022	16,617	2,607	3,910	469	6,147	2,136	1,667	33,554
2023	16,801	2,634	3,951	518	6,791	2,359	1,842	34,895
2024	16,986	2,661	3,991	572	7,501	2,606	2,034	36,353
2025	17,174	2,688	4,033	632	8,286	2,879	2,247	37,940
2026	17,364	2,716	4,074	698	9,154	3,181	2,482	39,669
2027	17,556	2,744	4,116	771	10,112	3,513	2,742	41,554
2028	17,750	2,772	4,159	852	11,170	3,881	3,029	43,613
2029	17,946	2,801	4,202	941	12,339	4,287	3,346	45,861
2030	18,144	2,830	4,245	1,040	13,630	4,736	3,696	48,320
2031	18,344	2,859	4,289	1,148	15,056	5,231	4,083	51,012
2032	18,547	2,889	4,333	1,269	16,632	5,779	4,510	53,959
2033	18,752	2,918	4,378	1,401	18,373	6,384	4,982	57,188

3.2 Outline Design

After reviewing of VEC F/S Interim Report, the following problems and issues are taken into consideration and improvement measures are proposed in this Outline Design;

(i) Upgrading 4-lane Expressway from existing Bypass for National Road No.1 (Highway) and Widening 6-lane.
(ii) Role of PV-CG road in Vietnam (In providing reasonable quality and high-speed transport services as an arterial South-North Expressway in Vietnam and the gateway to the City of Hanoi)
(iii) Basic Policies of the Inception Report(Safety, Environment, Quality, Cost and Process)

The following standards and regulations are applied to the project to upgrade PV - CG Section.

- Process of topographical drawings -industry standard 96 TCN 43-90;
- Standard of measurement techniques and GPS data processing in works geodesy TCXDVN 364-2006;
- The highway survey process 22 TCN 263-2000;
- The process of works geological exploration 22 TCN 259-2000;
- Process of highway surveys on soft soil 22 TCN 262-2000;
- The process of testing and determining overall elastic module of soft pavement by Benkelman TCN251-98-22;
- Expressway - Design Requirements TCVN 5729-97;
- Highways - Design Requirements TCVN 4054-2005;
- Rural Roads - Design Standards 22TCN 210-92;
- Soft pavement - Requirements and guidelines designed 22 TCN 211-06;
- Design process of hard pavement 22 TCN 223-95;
- Bridge Design standards for 22 TCN, 272-05;
- Steel Structures - Design Standards TCXDVN 338-2005;
- Bored piles - construction standards and acceptance TCXDVN 326-2004;
- Design of earthquake resistant building TCXDVN 375:2006;
- Public transport projects in the earthquake region 22 TCN 211-95;
- Loading and Impact - Design standards TCVN 2737-1995;
- Road Signs Regulation 22 BC 237-01;
-Process of tree cost norm 529/BXD/VTK-1997 norms.

Reference Standard
- Road and Structure Ordinance, Japan;
- The Design Guidelines of AASHTO;
- The other standards or design guidelines of foreign countries such as Highway Capacity Manual 2000 and Geometric Design Standards for Motorways by AASHTO.

3.2.1 Design of Road and Structures

Based on the above, main design policies of road design items are as follows.

[Design policy]

(1) Design Standard

Basically the design standards are based on those in Vietnam. However where appropriate standard and/or items do not exist in Vietnam standards, applicable standards from other countries are referred to and adopted to supplement Vietnamese standards.

(2) Design Speed

Design Speed as high as 120km/h is considered necessary to provide high-speed transport service since the PV-CG Expressway is a part of South-North Expressway in Vietnam and the gateway to the city of Hanoi.

(3) Vertical Alignment

For purposes of minimizing the impact on consolidation settlements and the loads worked on existing crossing structures, the thickness of the overlay is reduced.

(4) Median Strip

The type of barriers is decided in consideration of user's safety, minimum maintenance costs, and improvement of safety of maintenance works.

Reduction of width of the road in order to Minimize land acquisition is considered.

(5) Interchange

Since the PV-CG Expressway provides 6lanes in its complete profile, major improvement works are not planned at the stage of the 4lane upgrade but will be carried out at the stage of the 6 lane widening as necessary.

(6) Frontage Road

Grade and Width of the Road, Design Speed are decided in order to improve convenience of the residents and ensure their safety.

3.2.1.1 Road Grade and Design Speed

Road Grade and Design Speed of Existing Road and Plan is as follow,

[Existing Road] Highway
Design Standard; TCVN4054:1985
Road Grade; Grade I Plane
Design Speed (V_{design}); 100km/h
Width of Road;

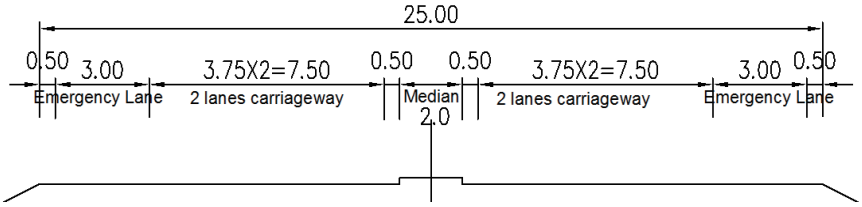


Figure 3.2.1-1 Width of Existing Road

[Plan] Expressway
Design Standard; TCVN5729:1997
Road Grade; Expressway Grade A
V_{design}; 100km/h or 120km/h

Scope of Design; Main line Km182+300～211+256 (L=28.956 Km)
Interchange Thuong Tin IC (approx. Km192+850),
Van Diem IC (approx. Km204+200)

Width of Road;
(4-lane)

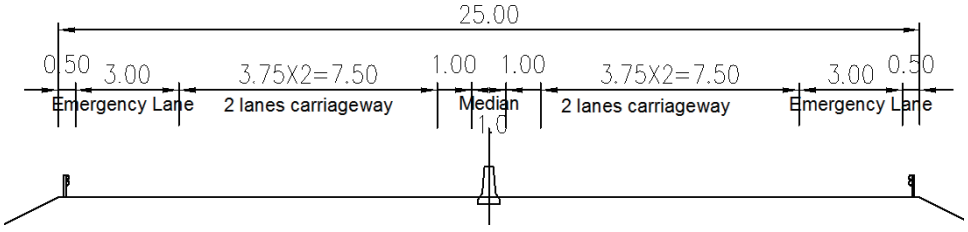


Figure 3.2.1-2 Width of Plan (Phase1:4-lane)

(6-lane)

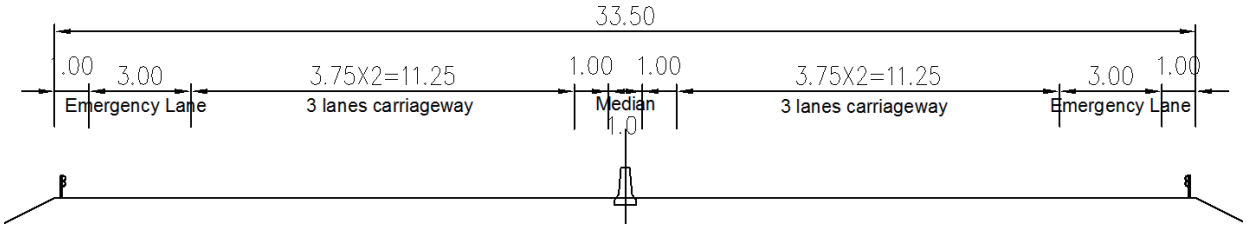


Figure 3.2.1-3 Width of Plan (Phase2:6-lane)

The PV-CG Expressway is aimed to provide high specification transport service because the PV-CG Expressway is an arterial South-North Expressway in Vietnam and the gateway to the city of Hanoi. Although Design Speed is considered to be V_{design}=120km/h, there are some locations to upgrade V_{design}=120km/h, where existing Bypass for National Road No.1 constructed as Highway with V_{design}=100km/h. In particular, vertical alignment has a problem. Because a radius of vertical curve of existing Van Diem Bridge (approx. Km204+200) is 6,000m, it is necessary to adjust the curve radius to 12,000m at V_{design}=120km/h by raising the surface by 30cm. Due to absorb an increase in dead load by raising surface, time and costs of the reinforcement works of the bridge. In the Outline Design, V_{design}=100km/h is applied to avoid significant modification works to minimize the effects to road users and to provide saving in time and costs.

Therefore there are two Design Speeds, such as V_{design}=120km/h and V_{design}=100km/h applied to the corresponding sections respectively. Following table shows Road Geometry specified in TCVN5729 : 1997, Expressway - Design Requirements, Vietnam, Road Structure Ordinance, Japan and AASHTO, USA.

Table Table 3.2.1-1 Road Geometry

		unit	Freeway/ Expressway Specification for Design TCVN5729		Road Structure Ordinance (JAPAN)						AASHTO(USA)		Remark
					Desirable	Ordinary	Relaxed	Desirable	Ordinary	Relaxed			
Design Speed		km/h	120	100	120			100			120	100	
Horizontal Alignment													
Min. Curve Radius		m	650	450	1,000	710	570	1,000	460	570	756	437	
Min. Curve Length		m	200.4	167		200			170		-	-	
Min.Transition Curve Length		m	125	100		100			85		-	-	
Vertical Alignment													
Max. Gradient	UP	%	4	5		2			3		-	-	
	Down	%	5,5	5,5		2			3		-	-	
Min. Curve Radius	crest	m	12,000	6,000	17,000	11,000		10,000	6,500		9,500	5,200	
	sag	m	5,000	3,000	6,000	4,000		4,500	3,000		6,300	4,500	
Min. Curve Length		m	100	85		100			85		-	-	
Min. Slope Length		m	300	140		-			-		-	-	
Stopping site distance		m	230	160		210			160		250	185	

A part of Table 7 Technical Standards for Expressway/Freeway Main lanes at the connecting elevated Interchange in TCVN 5729: 1997

			120		100	
			Ordinary	Relaxed	Ordinary	Relaxed
Main lanes in the vicinity of Interchange	Min. Horizontal curve radius		2,000	1,500	1,500	1,000
	Min. Vertical curve radius	crest	45,000	23,000	25,000	15,000
		sag	16,000	12,000	12,000	8,000
	Max. Vertical gradient		2	—	2	3

In this Outline Design, a study was made for selecting sections for V_{design}=120km/h and V_{design}=100km/h respectively. The same exercise was carried out in VEC F/S and only a minor difference is identified. In this regard, Detailed Design may be carried out based on the selection of sections in VEC F/S.

Table 3.2.1-2 Sections and Design Speed

	Design Speed (V_{design})	Section	Length	Remark
VEC F/S	100km/h	KM182+000～KM193+600	L=11.6km	
	120km/h	KM193+600～KM203+000	L=9.4km	【Enlargement for keeping sight distance】
	100km/h	KM203+00～KM211+000	L=8.0km	
JICA Study Team	100km/h	KM182+000～KM194+970	L＝12.970km	D1 : R=1193 ⊿W=0.675m,
	120km/h	KM194+970～KM201+670	L=6.7km	D2 : R=1205 ⊿W=0.648m
	100km/h	KM201+670～KM206+670	L=5.0km	D9 : R=995 ⊿W=1.206m
	120km/h	KM206+670～KM211+000	L=4.3km	D11 : R=1900 ⊿W=1.474m

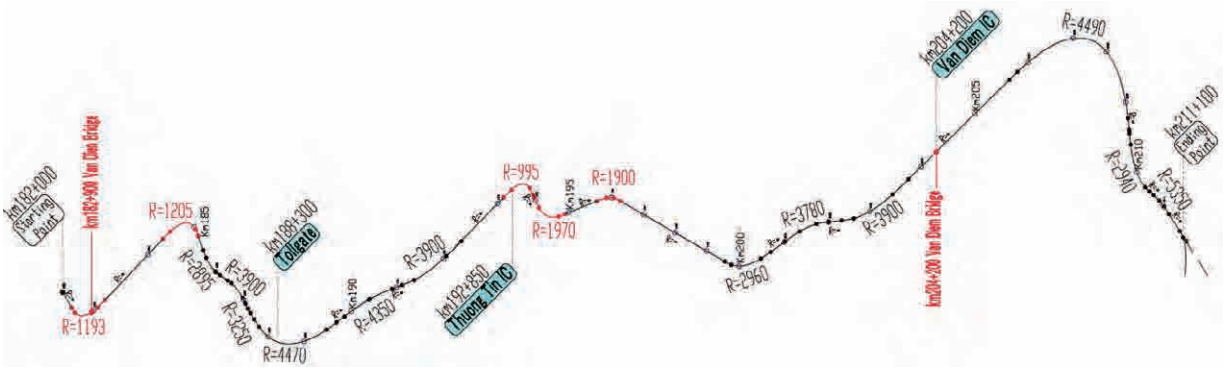


Figure 3.2.1-4 Horizontal Alignment

However it is noted that, from keeping traffic safety under standards in Japan, enlargements for keeping sight distance is required to apply alignments in VEC F/S. Details are shown in Attachment –Explanatory Note. Concept of sight distance is shown below.

[Sight Distance]

Stopping sight distance is the distance traveled while the vehicle driver perceives a situation requiring a stop, realizes that stopping is necessary, applies the brake, and comes to a stop.

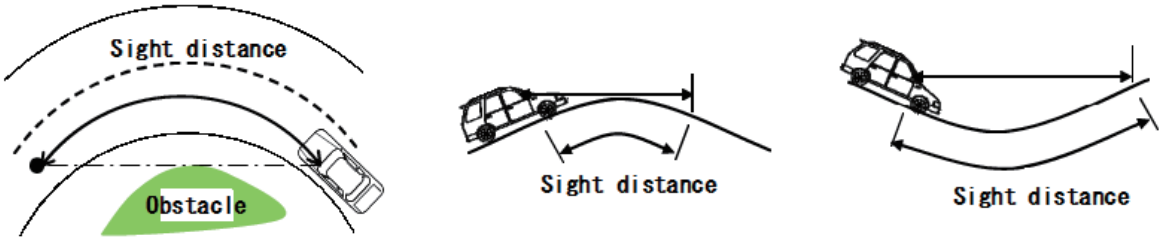


Fig. To ensure sight distance(Plan)

Fig. To ensure sight distance(Longitudinal)

Figure 3.2.1-5 Concept of Sight Distance

3.2.1.2 Vertical Alignment

The following items are taken into account for setting vertical alignment.

(i) Existing Bypass for NR-1 is to be upgraded to 4-lane Expressway and further extend to 6-lane in the near future

(ii) Typical section
Pavement strength represented by Elastic Modulus of existing Highway, obtained by Benkelman Tests, does not reach to the required strength calculated based on the traffic demand forecast. Remove and reconstruction of pavement gives considerable negative impact for existing traffic and it is not economical because strength of subgrade is less than that of the existing pavement. Overlay of required thickness to obtain the necessary pavement strength is to be carried out.
(Thickness of overlay is shown in Section 3.2.1.6 Pavement)

(iii) Bridges and Box culvert section
Because overlay increases overburden to the structures and reinforcement to those may become necessary, removal and reconstruction of pavement is carried out instead of overlay.

(iv) Because Highway locates on the soft ground, increase on overlay results in increase in overburden and induce further settlements. In this respect, it is required to minimize the thickness of overlay.

(v) TCVN5729:1997 Expressway - Design Requirements specifies Minimum Slope Length, a detail of which is shown in Table below and such provisions are neither included in Road Structure Ordinance, Japan nor in AASHTO, USA. Definition and provision of Minimum Slope Length is shown in Figure and Table below.

Table 3.2.1-3 Min. Slope Length

V_{design}	100km/h	120km/h
Min. Slope Length	250m	300m

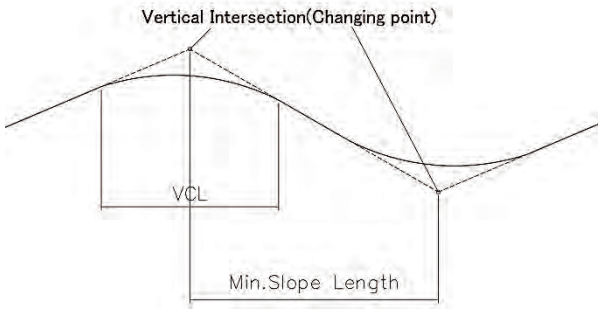


Figure 3.2.1-6 Definition of Min. Slope Length

(vi) Hanoi City experienced flooding damage frequently. With this respect, TCVN5729 : 1997 specifies pavement level of Expressway which is water level of 100 years return period, once per 100 years, plus 0.5m for an allowance. Also TCVN4054 : 2005 specifies that of frontage roads which is water level of 25 years return period, once per 25 years, plus 0.5m for an allowance. However pavement height of frontage roads become higher than the existing road and it is not convenient for neighborhood residents. The requirement of TCVN4054 : 2005 Highways - Design Requirements is not applied. Waters level for 100 years and 25 years return period are shown in the Table below.

Table 3.2.1-4 Design water level

No.	Station	Survey water level (m)			Design water level (m)	
		H_{1984}	H_{1994}	H_{2008}	$H_{1\%}$	$H_{4\%}$
1	Km182+000.00	5.42	5.2	5.29	5.51	5.33
2	Van Dien bridge Km182+926.99	5.72	5.30	5.12	5.34	5.16
3	Km184+500.00	5.53	5.33	5.24	5.46	5.28
4	Km185+448.58	5.61	5.51	5.32	5.54	5.36
5	Km186+651.42	5.58	5.28	5.13	5.35	5.17
6	Km187+616.40	5.77	5.37	5.07	5.29	5.11
7	Km188+000.00	5.78	5.37	5.03	5.25	5.07
8	Km189+388.23	5.37	5.08	4.91	5.13	4.95
9	Km190+884.85	5.49	5.24	5.10	5.32	5.14
10	Km192+349.27	5.60	5.35	5.10	5.32	5.14
11	Km193+600.00	4.52	4.34	4.13	4.30	4.16
12	Km194+858.55	4.67	4.57	4.08	4.25	4.11
13	Km196+000.00	4.65	4.43	4.40	4.57	4.43
14	Km196+909.49	4.73	4.54	4.40	4.57	4.43
15	Km197+259.00	4.10		4.00	4.32	4.03
16	Km198+500.00	4.03	3.69	3.70	3.87	3.73
17	Km199+560.00	4.50	4.32	4.25	4.42	4.28
18	Km200+528.92	4.28	4.03	4.10	4.27	4.13
19	Km201+514.12	4.42	4.11	4.17	4.34	4.20
20	Km202+526.56	4.15	3.90	3.97	4.14	4.00
21	Km204+185.00	4.20	3.99	4.05	4.22	4.08
22	Km205+850.00	3.95	3.76	3.81	3.98	3.84
23	Km207+850.00	3.60	3.50	3.45	3.62	3.48
24	Km207+931.38	4.10	3.88	3.90	4.07	3.93
25	Km209+468.20	3.30	3.12	3.10	3.27	3.13
26	Km211+149.14	2.64	2.40	2.45	2.62	2.48

Source : VEC F/S Final Report

Vertical Alignment included in VEC F/S Final Report considers all above requirement and becomes basis of the Detailed Design.

However because requirement of Min. Slope Length is included neither in standards of USA nor in those of Japan, such requirement may cause little adverse effect in travelling performance. In AASHTO and Road Structure Ordinance, there are provisions for maximum gradient, minimum radius of vertical curve and minimum length of vertical curve, which are so specified that required sight distance can be kept.

In the near future, there will be the same needs to upgrade existing highway to expressway like this project as the economy of Vietnam develops sustainably. Because funds for construction of expressway are not un-limited, it is necessary to save the construction cost by relaxing the requirements which have little adverse effects on travelling and safety performance. Saving will be utilized as a part of funds for construction of other Expressway.

Therefore further detailed study is to be carried out at Detailed Design stage regarding relaxation of the requirement of Min. Slope Length specifically for the sections which generate considerable saving by relaxation of such requirement. In this Outline Design, the following sections which have potential for saving, are identified.

Table 3.2.1-5 Recommendation of Min. Slope Length

	Standard	Relaxation(Recommendation)
V_{design}	100km/h	100km/h
Min. Slope Length	250m	200m

测点	区间长
183+468 183+695	227
185+495 185+730	235
186+330 186+566	236
187+157 187+380	223
188+790 189+025	235
190+865 191+065	200
192+180 192+395	215
193+600 193+840	240
195+175 195+410	235
195+825 196+030	205
196+030 196+235	205
196+235 196+440	205
196+440 196+640	200
196+917 197+150	233
201+780 201+980	200
202+326 202+530	204
202+530 202+750	220
202+750 202+950	200
203+715 203+960	245
203+960 204+200	240
204+530 204+730	200
206+160 206+380	220

Figure 3.2.1-7 Sections which needs relaxation of Min. Slope Length requirement is effective

3.2.1.3 Median

In order to upgrade the existing highway to the expressway, pavement needs to be strengthened by carrying out overlay with thickness not less than 30cm, as shown in below Figure. In this regard, median strip and safety barrier (guard facility) are required to be re-constructed. Because specification applied to median strip and safety barrier is changed to TCVN: 1997 Specification for Expressway in Vietnam, design of median strip and safety barrier should be reviewed considering design speed of the expressway, where V_{design}=100km or V_{design}=120km will be applied in general. The following conditions and items are taken into account for selection of the width of median strip and type of safety barriers.

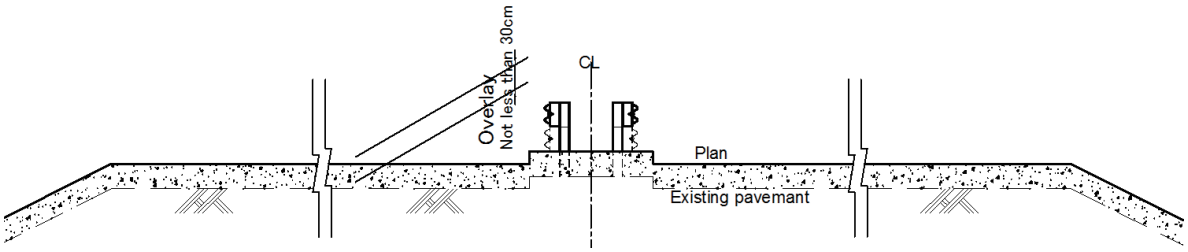


Figure 3.2.1-8 Concept of Overlay

(1)Condition of Study

TCVN5729:1997 Specification for Expressway in Vietnam specifies the width of median separator and safety strip as shown in Table3.2.1.6 corresponding to its design speed, i.e. V_{design}=100km/h and = V_{design} 120km/h.

Table 3.2.1-6 Width of median separator and safety strip

	V_{design}=100km/h	V_{design} 120km/h
Width of Safety strip:	not less than 0.75m	not less than 0.75m
Width of Median separator:	not less than 0.5m	not less than 1.0m

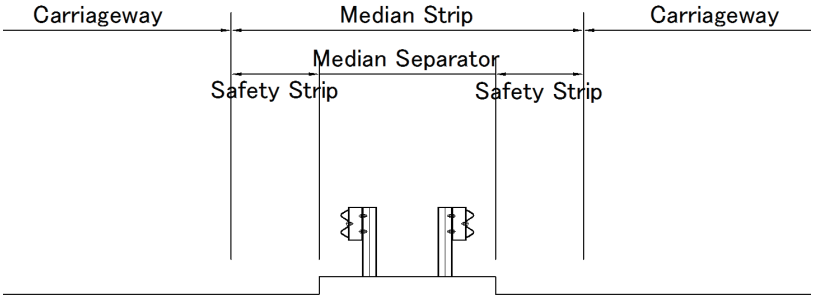


Figure 3.2.1-9 Definition of terms

(2) Selection criteria with regards to Median strip

* Required area for median strip is minimized as practically as possible.

(3) Comparison criteria with regards to Safety barriers in Attachment 3

* Safety
* Maintenance sufficiency
* Procurement of products
* Cost

A width of Median Strips shown in the above Figure is minimized considering the following two items.

(i) At the time of Phase I (4-lane) a total Road width is to be the same as that of existing highway

(ii) Continuity of Median Strips to Cau Gie- Ninh Binh Section, 1.0+3.0+1.0＝4.0m, at the connection point

At the same time, a rigid type concrete barrier is proposed for installation at the Median Separator. A comparison between a rigid type concrete barrier and a steel guard rail is shown in the Table 3.2.1-7 and further detailed study is shown in Attachment.

Table 3.2.1-7 Proposed Profile

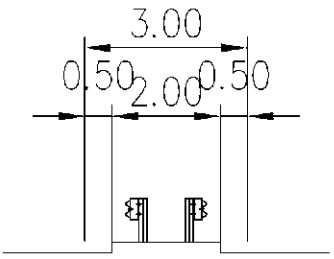
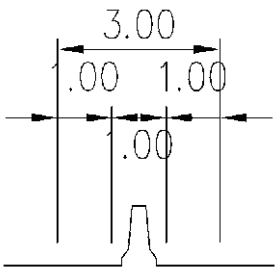
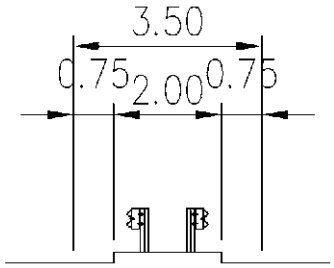
Existing profile (Typical section, Pier section)	Proposed profile：4 lane Carriageway・6 lane Carriageway	
	Typical section (Approx. 28.4km)	Pier section (Approx. 0.3km)
		

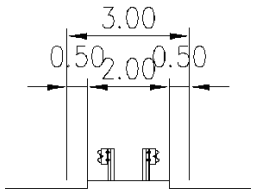
Table 3.2.1-8 Comparison of Safety Barriers

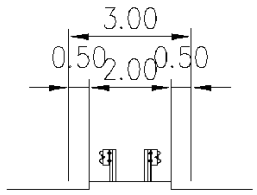
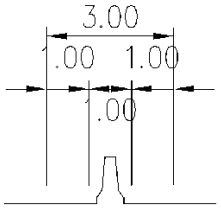
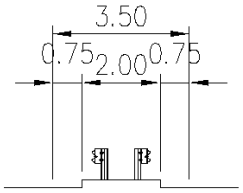
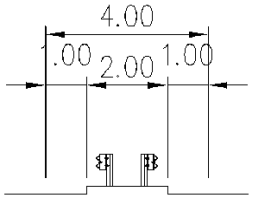
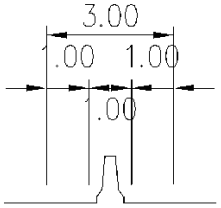
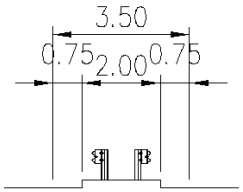
Comparison of Safety Barriers Rating: ◎: Excellent, ○:Good, △: Fair, ×: No Good

Item	Guard Rails×2	Rating	Rigid type Barriers	Rating	Remarks
Profile					
Safety Features	* Non-rigid type safety barrier is designed to absorb impact by its deflection. * It has the following functions (1) Preventing vehicle from crossing over a median and striking an on coming vehicle in a head-on crash (2) Ensuring passenger's safety (3) Redirecting vehicle into a path parallel to the barrier (4) Preventing barrier materials from fracturing	○	* Rigid barrier safety barrier is designed to resist an impact of crash without plastic deformation. *It has the following functions and good performance. (1) Preventing vehicle from crossing over a median and striking an on coming vehicle in a head-on crash (2) Ensuring passenger's safety (3) Redirecting vehicle into a path parallel to the barrier (4) Preventing barrier materials from fracturing	◎	
Durability	Fair durability	△	Excellent durability	○	
Estimated Cost (per M)	3,395,500VND/m * Reuse Guardrails	△	2,660,850VND/m	○	
Maintenance	* Replacement required for damaged area. * Maintenance necessary for planting and trees. * Unsafe work at the middle of median strip when pruning.	△	* Maintenance free.	○	
Procurement of Materials	* Imported materials	△	* Locally procured materials (Reinforced concrete)	○	
Road Width and Sight Distance	Compared with Rigid type Barriers, * Wider median strips and width of the road by 0.5m for 4-lane carriageway and by 1.0m for 6-lane carriageway respectively. * Wider width of the road for sight distance by 0.25m.	△	Compared with Guard Rails, * Narrower median strips and width of the road by 0.5m for 4-lane carriageway and by 1.0m for 6-lane carriageway respectively. * Narrower width of the road for sight distance by 0.25m.	○	
Others	·Area available for street light installation.	○	* Area for street light not available but only beside road shoulder. * Interlocked barriers in 50m length sufficient against impact. * Allowable bearing capacity of the ground needs not less than 150kN/m2.	○	
Comprehensive Evaluation	△		○		

Table 3.2.1-9 Width of Median Strip

Width of Median Strip

	Category of Road	Sectional profile	120km/h	100km/h	80km/h
Existing	National Road		Standard for National Road ○	Standard for National Road ○	○

	Category of Road	VEC-FS				ST Proposal					Remarks
		Sectional profile	120km/h	100km/h	80km/h	Sectional profile		120km/h	100km/h	80km/h	
						Typical section	Interchange/Pier section				
4 lane Carriage way	Expressway	 *1)	×	×	○	 *2)	 *3)	○ Not less than R=2100m	○	○	On bridge section, width of safety strip remains at 0.75m with shoulder width reduced by 0.25m
						Typical /Interchange section	Pier section				
6 lane Carriage way (Future)	Expressway		○	○	○	 *2)	 *3)	○ Not less than R=2100m	○	○	

*1) While PVCG is 4 lane carriageway with V=100km/h, it is operated provisionally with width of median strip indicated.
*2) In case of installing Kilo meter post/Street light, Kilo meter post/Street light are placed on both sides.(For example, refer to attachment1)
*3) Typical and particular section are to be connected smoothly.

【Transition Section between PV-CG Expressway and Cau Gie - Nihn Binh Expressway】

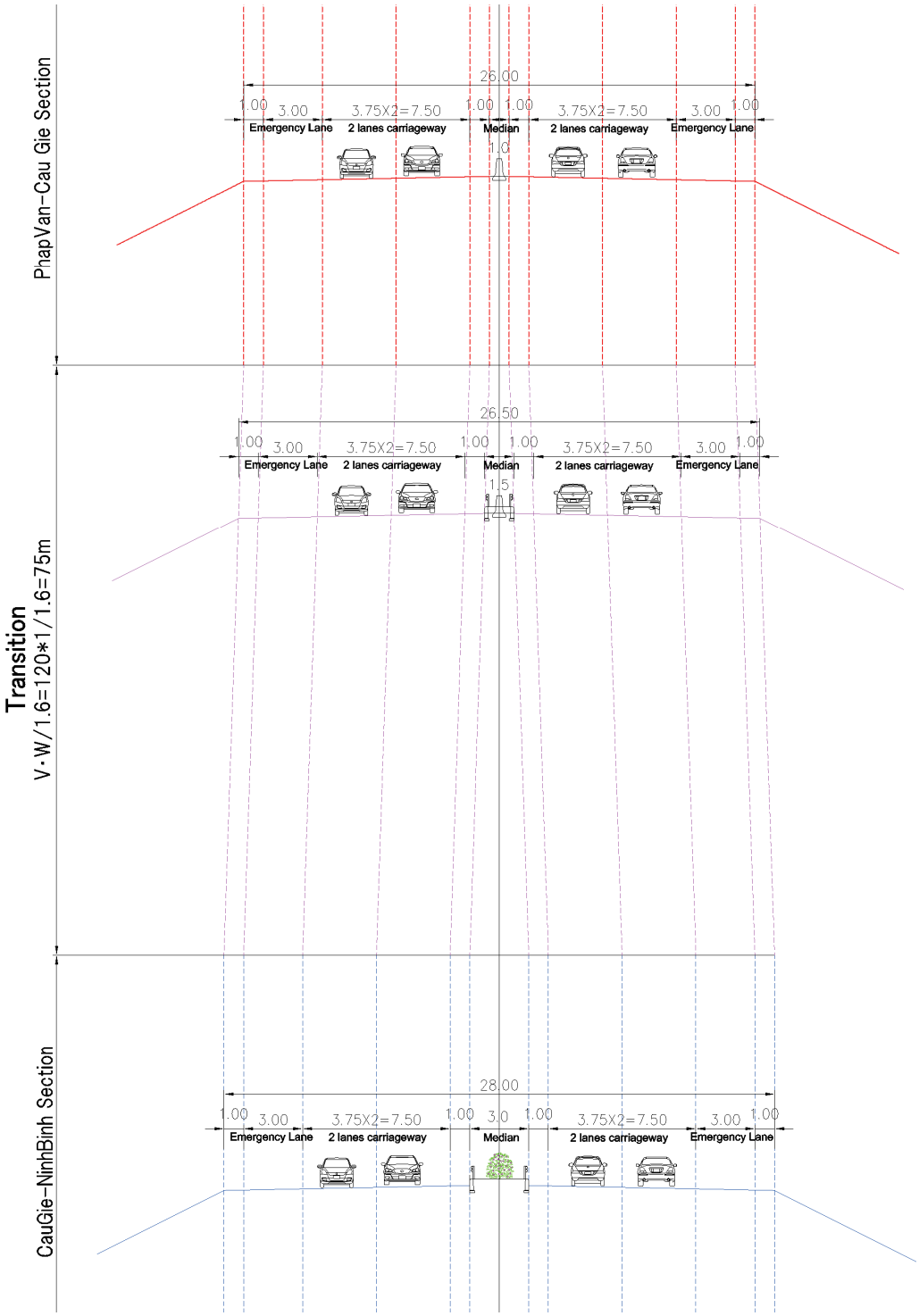


Figure 3.2.1-10 Transition Section for Median Strip continuity

3.2.1.4 Interchanges and Toll Gates

In PV-CG Expressway, there are two interchanges, ie Thuong Tin IC (Km192+850) and Van Diem IC (Km204+200). Phap Van IC at starting point of PV-CG Expressway was already completed and Dai Xuyen IC at the ending point will be constructed under the contract for the section of Cau Gie-Ninh Bin. All toll gates including that installed at Main Lanes of PV-CG Expressway will be constructed under the contract. Currently planning for tollgates and Interchanges are under review. There is no toll gate installed at Phap Van IC because toll gates at the Main Lanes will be installed between Phap Van IC and Thuong Tin Interchange.

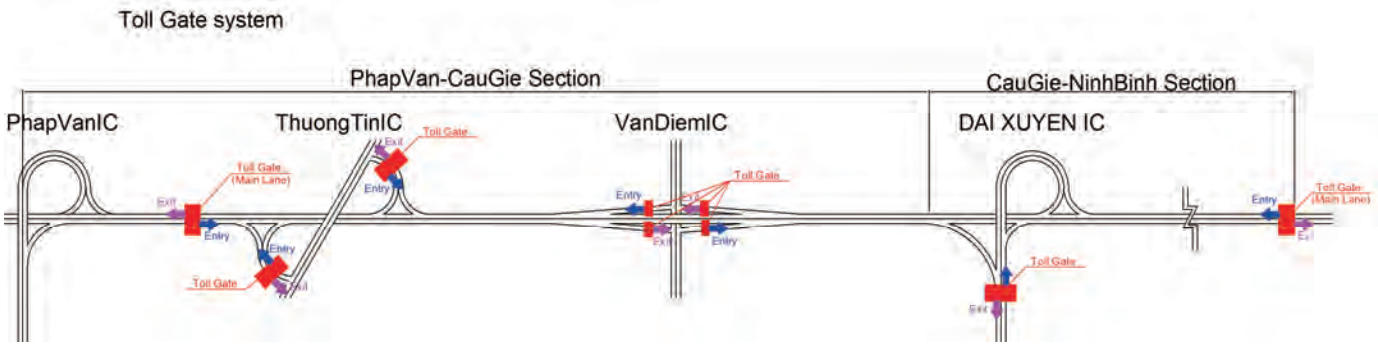


Figure 3.2.1-11 Location of Interchanges and Toll Gates

The following points are to be taken into consideration.

【Points to be considered for ICs and Toll Gates】

(i) It is important to keep smooth traffic at the Main Lanes of Expressway and access roads are to be constructed for entry to/exit from Expressway. No direct connection from Expressway to Frontage Road is entertained.

(ii) From operation point of view, Toll Gates are to be installed as close as possible to save time and cost for staff allocation, supervision and management.

(iii) Design is to be made with consideration of Phase II, 6-lane widening. Toll gates are so designed to minimize abortive costs incurred.

【Geometric Design】

Design Speed of Main Lanes : Thuong Tin IC 100km/h
Van Diem IC 100km/h

Table 3.2.1-10 Technical standards for freeway/expressway at the connecting elevated

The grades of expressway			120	100	80	60
The minimum radius of the horizontal curve		Normally	2,000	1,500	1,100	500
		Limited	1,500	1,000	700	350
The minimum radius of the vertical curve	Convex	Normally	45,000	25,000	12,000	6,000
		Limited	23,000	15,000	6,000	3,000
	Concave	Normally	16,000	12,000	8,000	4,000
		Limited	12,000	8,000	4,000	2,000
The largest longitudinal gradient, %		Normally	2	2	3	4.5
		Limited	2	2	4	5.5

Source: TCVN5729：1997 Table7

Table 3.2.1-11 The minimum length of the triangle lane-changing section (current separating or joining)

Grades of freeway/ expressway	120	100	80	60
L_n	75	60	50	40

Source: TCVN5729：1997 Table9

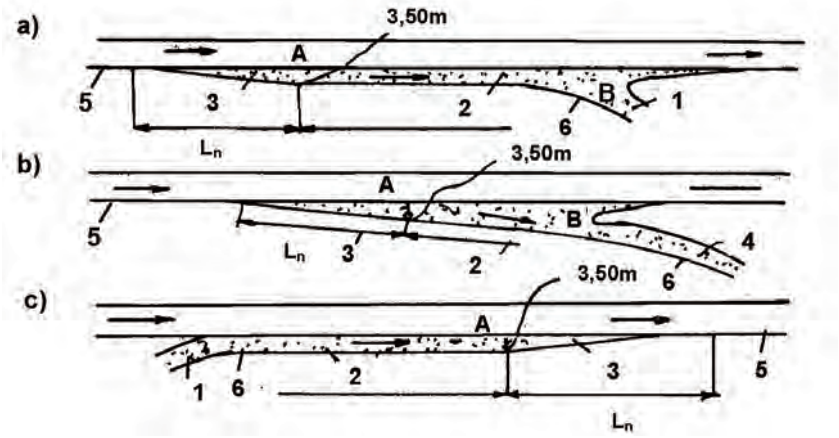


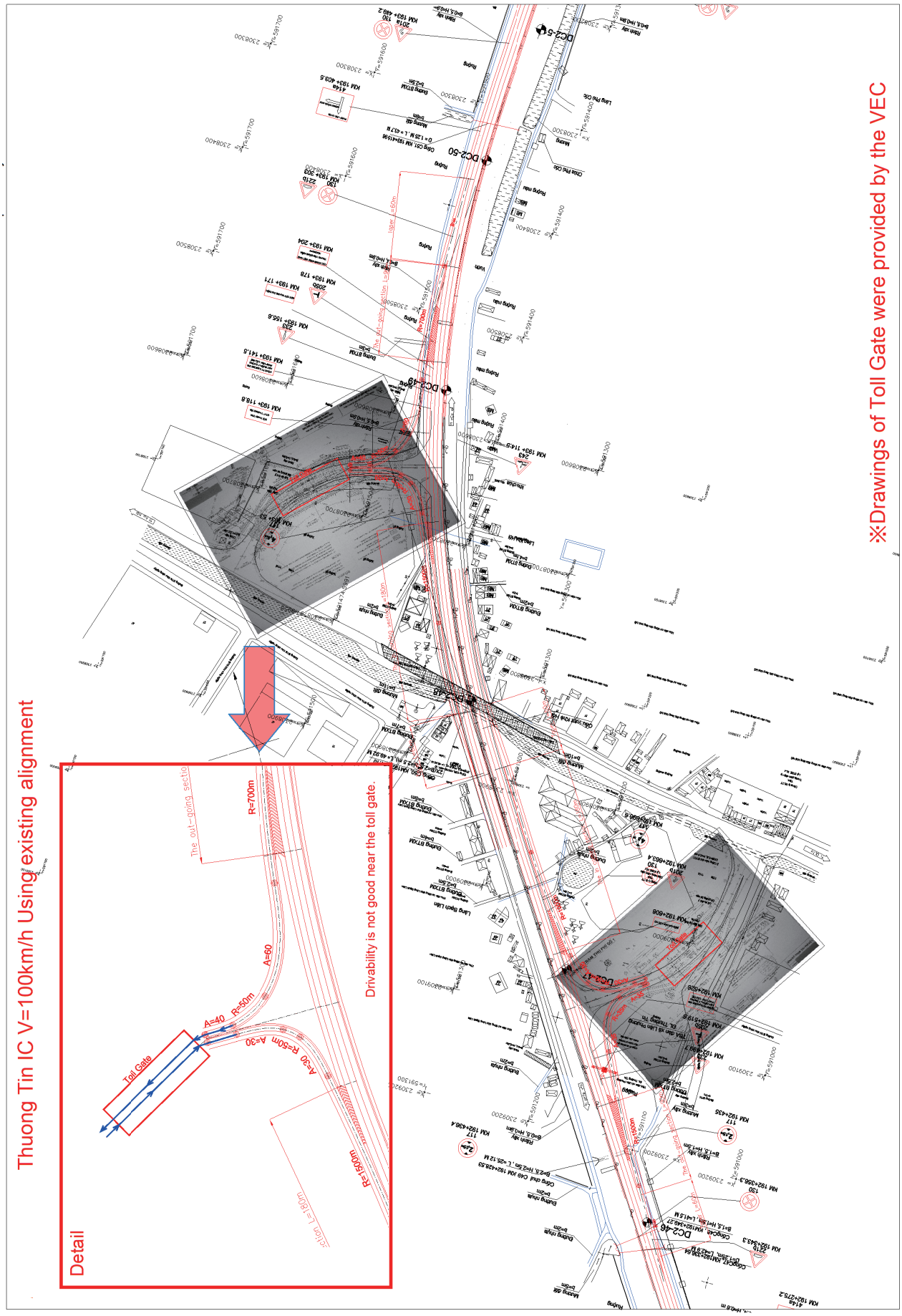
Figure 3.2.1-12 The ways of locating out-going and in-coming section (Source: TCVN5729：1997 Figure 5)

Table 3.2.1-12 The minimum value applied to the total length of the lane-changing section plus the speed-changing section.

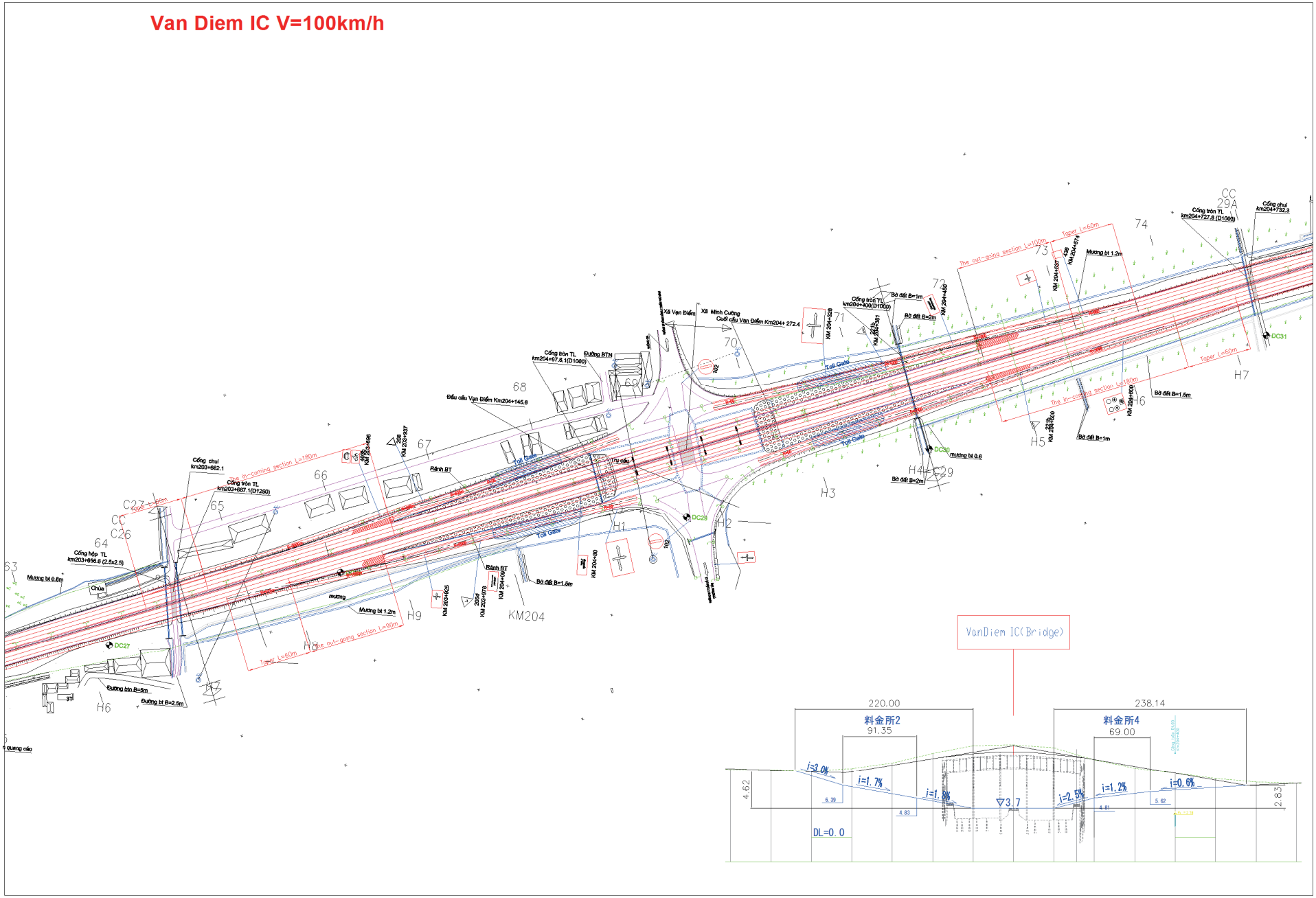
Grades of expressway	120	100	80	60
The minimum length at exit point (reducing speed) of one lane, m	100	90	80	70
The minimum length at entry point (increasing speed) of one lane, m	200	180	160	120

Source: TCVN5729：1997 Table12

As a reference, an Interchange Plan is attached to the next page.


Thuong Tin IC V=100km/h Using existing alignment
※Drawings of Toll Gate were provided by the VEC
Detail
Toll Gate
R=700m
A=60
A=40 R=50m
A=30 R=50m A=30
R=500m
Drivability is not good near the toll gate.

Van Diem IC V=100km/h



3.2.1.5 Frontage road

Along with the 6-lane widening of PV-CG Expressway, the existing frontage roads need to be moved. At the same time, discontinuous frontage roads need to be improved and to be raised for convenience of roadside residents.

Because motor bikes will not be allowed to drive in Main Lanes by upgrading Highway to Expressway, alternative roads for motor bikes are to be provided.

New roads a length of which is approx. 20km are planned to construct by Hanoi City at the east side and Cau Gie side of PV-CG Expressway.

Considering the above points, mainly its functions and roles, grade of road, design speed, road width and road formation level are designed.

(1) Basic design principle for Frontage Roads

(Existing) Width of Frontage Roads are narrow (approx. 2 to 3m) and they are not continued.
Frontage Roads may be covered by embankment for 6-lane widening.
(relocation is necessary)

(Design) Width of Frontage Roads is not less than 3.5m is to be kept
Frontage Roads are to be continued.

(2) Road Grade and Design Speed of Frontage Roads and Hanoi City Road

Road grade and design speed is shown in the Table below.

【Frontage Road】

Table 3.2.1-13 Road Specification

	VEC F/S	JICA Study Team
Design standard	TCVN4054：2005	
Road Grade	Grade V	Grade VI
Design Speed	V=40km/h	V=30km/h
Road configuration	W＝7.5m (Pavement Width, PW=5.5m)	W＝5.5m (PW=3.5m)

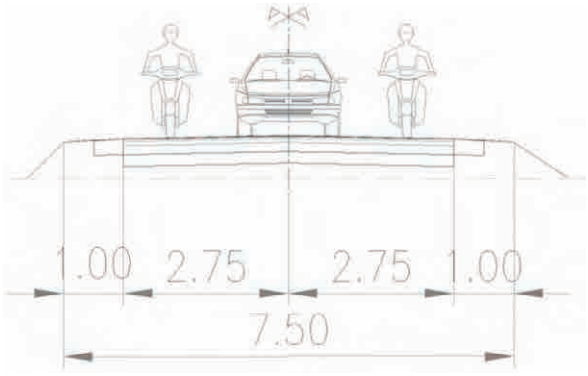


Figure 3.2.1-13 Frontage Road Configuration (VEC F/S)

Table 3.2.1-14 Highway Technical Classification according to function and design traffic volume

Design categories	Design traffic volume (PCU/daily)	Major functions of highway
Expressway	> 25.000	Arterial road, in compliance with TCVN 5729:1997
I	> 15.000	Arterial road, connecting large national economic, political, cultural centers National Highway
II	> 6.000	Arterial road, connecting large national economic, political, cultural centers National Highway
III	> 3.000	Arterial road, connecting large national and regional economic, political, cultural centers National Highway or Provincial Road
IV	> 500	Highway connecting regional centers , depots, residential areas National highways, Provincial road, District roads
V	> 200	Road serving for local traffic. Provincial road, district road, communal road
VI	< 200	District road, communal road
* These values are for reference. Selection of road classification should base on road function and terrain type.		

Source: TCVN4054：2005 Table 3

Table 3.2.1-15 Design speed of each road category

Design categories	I	II	III		IV		V		VI	
Topography	flat	flat	flat	mountain	flat	mountain	flat	mountain	flat	mountain
Design speed, V_{tk} (km/h)	120	100	80	60	60	40	40	30	30	20
NOTE: Classification of the terrain is based on common natural slope of the hill side and mountain side as follows: flat and rolling ≤ 30%; Mountain > 30%.										

Source: TCVN4054：2005 Table4

Table 3.2.1-16 Minimum width of cross-sectional elements applied for flat rolling terrain

Design categories	I	II	III	IV	V	VI
Design speed, (Km/h)	120	100	80	60	40	30
Minimum number of lanes for motorized vehicle,(nos)	6	4	2	2	2	1
Width of a lane, (m)	3.75	3.75	3.5	3.5	2.75	3.5
Width of traveled way for motorized vehicle, (m)	2 ×11.25	2 ×7.50	7.00	7.00	5.50	3.50
Width of median separator[1)], (m)	3.00	1.50	0	0	0	0
Width of shoulder and stabilized part of shoulder[2)], (m)	3.50 (3.00)	3.00 (2.50)	2.50 (2.00)	1.00 (0.50)	1.00 (0.50)	1.50
Width of roadbed, (m)	32.5	22.5	12.00	9.00	7.50	6.50

1) Width of median separator for each structure is defined in Article 4.4 and Figure 1. The minimum value is applied for separator made of pre-cast concrete or curb stone with cover and without constructing piers (poles) on separated bands. In other cases, separator width must comply with provisions in Article 4.4.

2) Number in the bracket is the minimum width of stabilized part of shoulder. If possible, it suggests to stabilize the whole shoulder width, especially when the highway without side lane for non-motorized vehicles.

Source: TCVN4054：2005 Table6

【Hanoi City Road】

Design standard：TCVN4054：2005

Road Grade：Grade III

Design Speed：V=80km/h

Road Width：W＝12.0m (PW=11.0m)

Number of lanes: Dual 2-lane

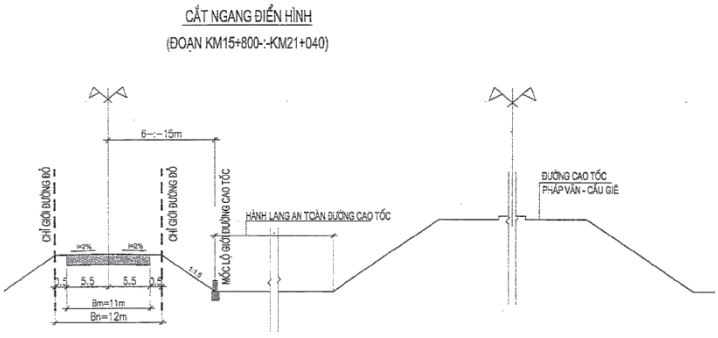


Figure 3.2.1-14 Hanoi City Road

Hanoi City Road is constructed in parallel to PV-CG Expressway and it connects Road No.71 to Cau Gie Interchange.

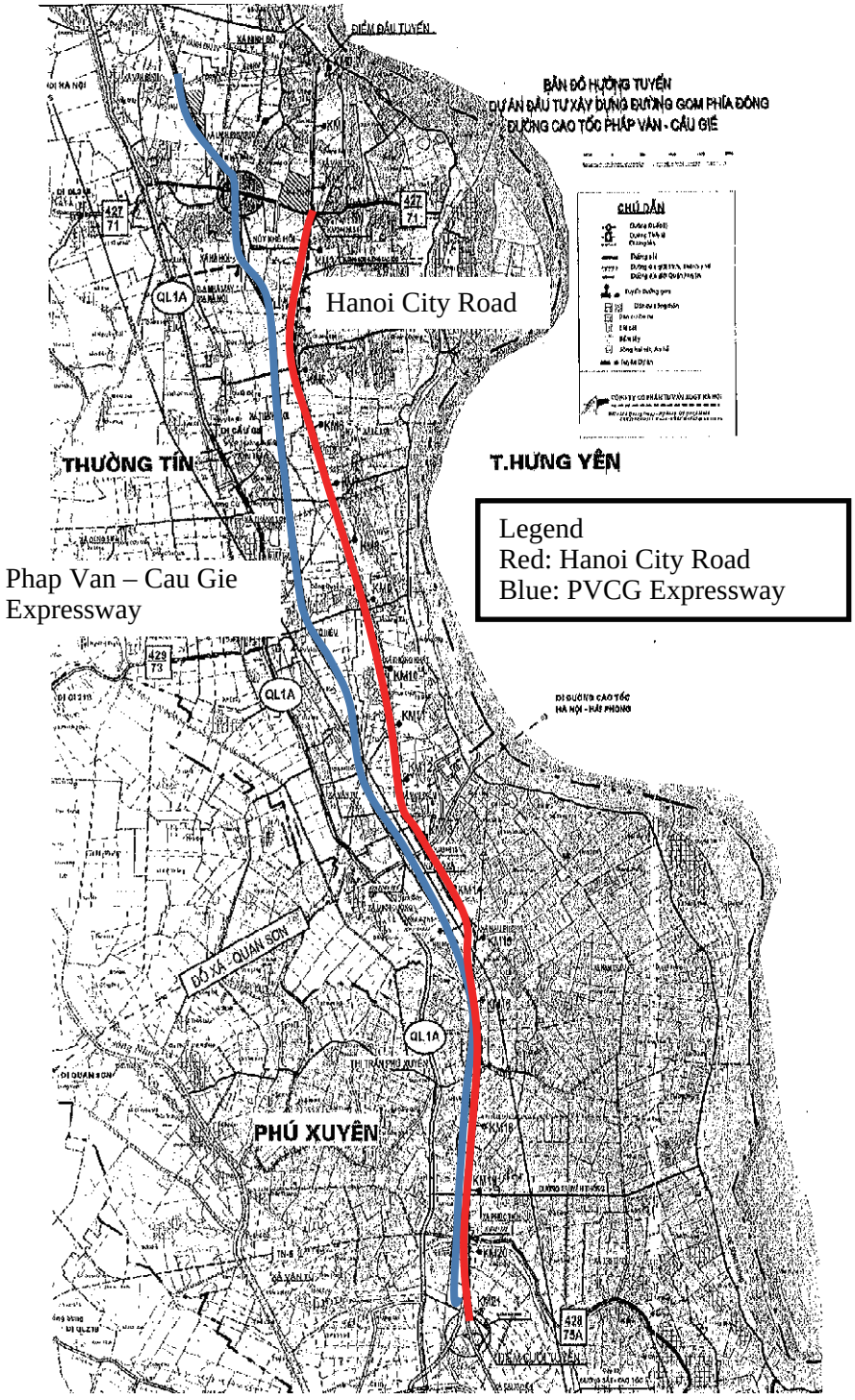


Figure 3.2.1-15 Plan of Hanoi City Road

(3) Pavement surface level of Frontage Roads

Pavement surface level of Main Lines of Expressway is decided at not less than flood level for 100 years return period plus 50 cm allowance as per TCVN 5729: 1997. In case that pavement surface level of Frontage Roads is decided at not less than flood level for 25 years return period

plus 50 cm allowance as per TCVN4054: 2005, such level is 1m or more higher than that of existing Frontage Road. The following problems are envisaged.

(i) Gradient to access part to the box culvert, which sits on piling foundation and level cannot be changed, becomes steep.

(ii) In residential area, level of roads becomes higher than that of housing land. It is inconvenient to the residence.

Therefore, considering convenience of residence and connection to the box culvert, the level of Frontage Road is decided at:

(i) not less than the level of existing road plus 10cm

(ii) not less than the level of 25 years return period

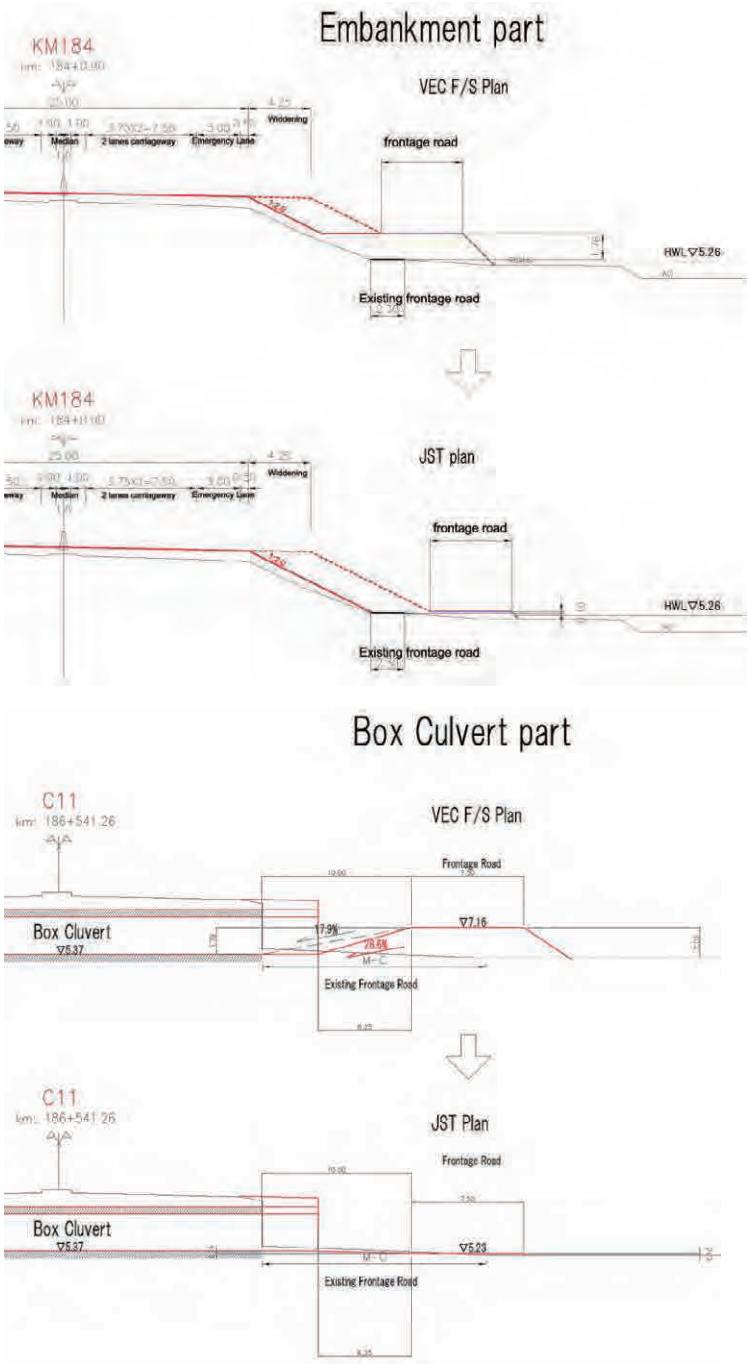


Figure 3.2.1-16 Level of Frontage Roads

3.2.1.6 Pavement

(1) Pavement Design

Following two cases of pavement design are made.

Table 3.2.1-17 Pavement Design cases

Timing / Locations	Phase I: Upgrade to Expressway (4lanes)	Phase II: Widening to 6 lanes
Typical sections, Existing 4 lanes	Overlay on existing pavement	same as on the left, if necessary
Adjacent sections of existing box culvert, Existing 4 lanes	Remove existing pavement and construct pavement onto subgrade	Ditto Case a
Sections for Widening two lanes (newly constructed)	Case b	construct pavement onto subgrade

VEC F/S (**PHAP VAN CAU GIE UPGRADING PROJECT, FEASIBILITY STUDY INTERIM REPORT August 2011**）was reviewed**.**

Vietnam pavement design is checked whether pavement strength E_{ch} (Elastic modulus) calculated from Elastic modulus of pavement component, such as surface course, binder course, road base, sub-base, sub-grade, exceeds required strength E_{yc} specified by road classification, traffic volume, considering reliability factor: K_{cd}^{dv}.

$$E_{ch} \geq K_{cd}^{dv} \times E_{yc}$$

The calculating method is multilayers (2 layers) elasticity theory. From E_1 for pavement excluding sub-grade and E_0 for sub-grade, E_{ch} can be calculated using nomograph.

In case of the improvement of existing 4 lanes that is overlay to existing road so instead of strength of subgrade (CBR) , strength(elastic modulus) of existing road was calculated by Benkelman beam test. Review was made in according with 22TCN251-98 (Benkelman beam test), 22TCN263-2000 (Road investigation) and 22TCN211-06 (Pavement thickness, traffic volume).

a) The improvement of existing 4 lanes （Overlay the existing pavement）

The flow of pavement design of improvement 4-lanes is shown in Figure 3.2.1-4.

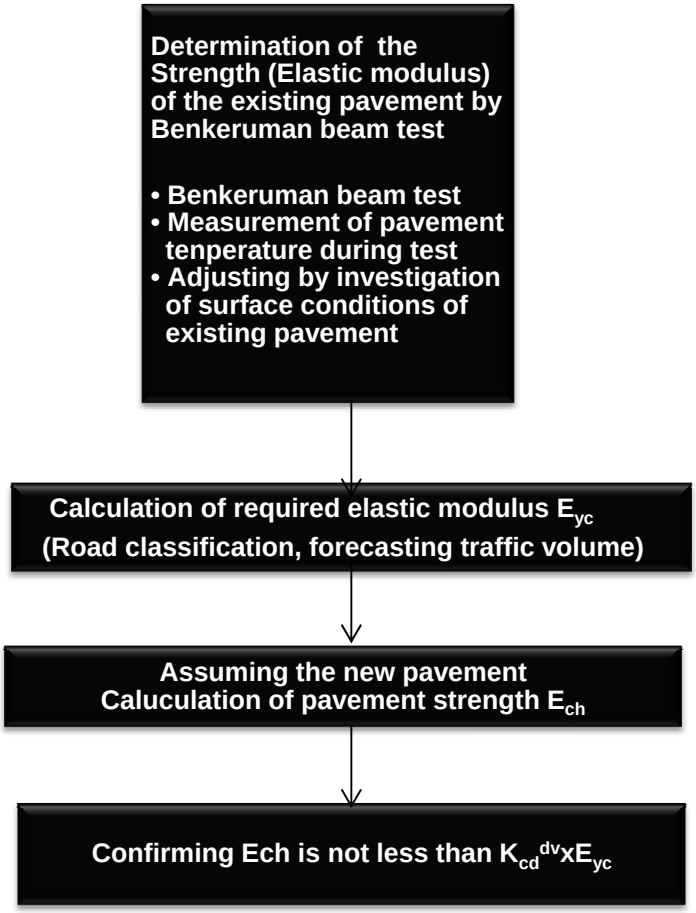


Figure 3.2.1-17 The flow of pavement design of improvement 4-lanes

i) Result of the Characteristic Elastic Module E_{dt} of existing pavement

The test result of Characteristic Elastic Module E_{dt} of existing pavement by VEC F/S and review by JST (JICA Study Team) is shown in Table 3.2.1-18. The test was performed each 200m.

Table 3.2.1-18 Result of the Characteristic Elastic Module E_{dt} of existing pavement

Unit: daN/cm^2

Lane	Starting point	Ending point	distance (m)	VEC FS E_{dt}	JST review E_{dt}
Right	Km181+600.00	Km182+700.00	1100	1023	1007
	Km182+700.00	Km185+300.00	2600	1189	1178
	Km185+300.00	Km191+900.00	6600	1201	1178
	Km191+900.00	Km197+300.00	5400	1387	1372
	Km197+300.00	Km200+700.00	3400	1665	1643
	Km200+700.00	Km207+500.00	6800	1301	1301
	Km207+500.00	Km212+200.00	2500	1601	1601
Left	Km180+700.00	Km181+800.00	1100	1125	1115
	Km181+800.00	Km188+400.00	6600	1146	1135
	Km188+400.00	Km191+600.00	3200	1403	1387
	Km191+600.00	Km198+400.00	6800	1328	1328
	Km198+400.00	Km206+000.00	7600	1343	1328
	Km206+000.00	Km211+300.00	5300	1601	1581

The result of PHAP VAN CAU GIE UPGRADING PROJECT Volume 1.2 Pavement Investigation Report, 10-TEDI-027-HD as basic data of VEC F/S can be considered generally valid.

ii) The traffic demand forecast

The comparison between Traffic volume demand forecast in 2030 by VEC FS and JST(JICA Study Team) is shown in Table 3.2.1.6-4 The comparison of the traffic volume demand forecast in 2030 between by VEC FS and JST.

Table 3.2.1-19 Traffic Demand Forecast in 2030 by VEC FS and JST

	VEC FS		JST	
Vehicle type	Phap van-Thuong Tin	Thuong Tin-Cau Ghe	Phap van-Thuong Tin	Thuong Tin-Cau Ghe
Passenger car	27,013	28,028	26,841	14,548
Small bus	6,264	6,951	2,977	3,205
Heavy bus	7,461	8,562	4,465	4,807
Small truck	4,284	4,275	1,363	1,371
Medium truck	1,071	1,069	17,868	17,979
Heavy truck	342	1,457	6,209	6,247
Heavy truck distance between rear axles is 3m or more	147	624	4,846	4,876
Total	46,582	50,966	64,569	53,033

iii) Required elastic modulus(E_{yc})

Review result of Required elastic modulus **(E_{yc})** is shown in Table 3.2.1.6-5 The comparison of Required elastic modulus (**E_{yc}**) between VEC FS and JST is shown in Table 3.2.1.6-6. Calculating method is followed 22 TCN211-06. However, both traffic surveys did not followed 22TCN211-06. That standard request the exact vehicle classification, so in the detailed design should be more detail studied.

Table 3.2.1-20 The comparison of Required elastic modulus (E_{yc}) between VEC FS and JST

(Unit: Mpa)

Station / Reviewed by	Phap van-Thuong Tin※	Thuong Tin※-Cau Gie
VEC FS	190	200
JST	226	227

※Thuong Tin (192km+900)

Minimum elastic modulus (**E_{yc}**) from 22TCN211-06 is shown in the table below.

Table 3-5: Minimum value of required elastic modulus (MPa)

Road type and class	Type of surface layer of design pavement structure		
	High-grade A1	High-grade A2	Low-grade B1
1. Highway/road			
- Expressways and Class I	180 (160)		
- Class II road	160 (140)		
- Class III road	140 (120)	120 (95)	
- Class IV road	130 (110)	100 (80)	75
- Class V road		80 (65)	Not stipulated
- Class VI road			
2. Urban road			
- Expressways and arterial road	190		
- Regional main road	155	130	
- Street	120	95	70
- Industrial road and warehouse	155	130	100
- Non-motorized road, lane	100	75	50

Note to Table 3-5:

- Values in parentheses are the minimum required elastic modulus for the structure of the hard shoulder.

Calculation cases, calculation method and way of determination of Ech

After determining the required elastic modulus value, it is probable that there are 2 calculation cases:

Recheck the proposed structural alternatives of pavement structure including material layers with the supposed thickness whether satisfactory to conditions (3.4) or not. In this case, Ech shall be calculated for the whole structure and then compared with a product K_{cd}^{dv}. Eyc for assessment. This is also the calculation case for assessing the strength of the existing pavement structure.

Knowing the product K_{cd}^{dv}. Eyc, carry out calculating the pavement thickness to satisfy the condition (3.4)

iv) Calculating result of necessary elastic modulus (K_{cd}^{dv} x E_{yc})

Table 3.2.1-21 The comparison of necessary elastic modulus (K_{cd}^{dv} x E_{yc})

	Phap van-Thuong Tin	Thuong Tin-Cau Gie
Required elastic modulus E_{yc}	226	227
Necessary elastic module K_{cd}^{dv} x E_{yc}	248.6	249.7

*Relaiability 90% is applied.

v) Review of pavement design(overlay)

JST used Aggregate type 1 with cement 6% instead of Aggregate type 1 applied in VEC FS for absorbing increase in thickness due to increase in required elastic modulus corresponding to traffic demand forecast by JST. Aggregate type 1 with cement 6% is the

same as that applied in VEC FS for pavement design (new 6 lanes).

Aggregate type 1 with cement 6% has greater strength than Aggregate type 1. Quality of another layers are same as that in VEC FS.

Table 3.2.1-22 Comparison of pavement design between VEC FS and JST

Locations			VEC FS							JST Review		
Lane	From (station)	To (station)	Length (m)	E_{dt} (daN/cm^2)	Rough-ness layer (cm)	Fine grain asphalt concrete (cm)	Coarse grained asphalt concrete (cm)	Aggregate type 1 (cm)	The total thickness increase (cm)	Aggregate type 1 with cement 6% (cm)	E_{ch}	$K^{dv}_{cd} \times E_{yc}$
Right lane	Km181+600	Km182+700	1100	1023	3	5	7	25	40	25	254.2	244.2
	Km182+700	Km185+300	2600	1189	3	5	7	20	35	20	260.7	244.2
	Km185+300	Km191+900	6600	1201	3	5	7	18	33	18	259.4	244.2
	Km191+900	Km197+300	5400	1387	3	5	7	15	30	15	254.1	246.4
	Km197+300	Km200+700	3400	1665	3	5	7	12	27	12	269.7	246.4
	Km200+700	Km207+500	6800	1301	3	5	7	20	35	20	254.2	246.4
	Km207+500	Km210+000	2500	1601	3	5	7	12	27	12	267.4	246.4
Left lane	Km180+700	Km181+800	1100	1125	3	5	7	20	35	20	256.3	244.2
	Km181+800	Km188+400	6600	1146	3	5	7	20	35	20	250.1	244.2
	Km188+400	Km191+600	3200	1403	3	5	7	10	25	10	252.9	244.2
	Km191+600	Km198+400	6800	1328	3	5	7	18	33	18	256.2	246.4
	Km198+400	Km206+000	7600	1343	3	5	7	15	30	15	265.3	246.4
	Km206+000	Km211+300	5300	1601	3	5	7	12	27	12	265.2	246.4

b) The improvement existing 4 lanes road (Reconstruction of the existing pavement) and new 2 lanes for 6 lanes widening (new construction)

(i) Design Method

Calculation method of The improvement existing 4 lanes road is using CBR value instead of i) elastic modulus of existing pavement (Characteristic Elastic Module) Edt. CBR value is using CENTRAL NEXCO Study of pavement by Japanese TA method**.** In this regard, CBR is 6%. A method in 22 TCN 211 – 06 B.4 is applied to convert CBR to elastic modulus method. Experimental correlation between elastic modulus E_o and load bearing ratio CBR is 3.4. Some experimental relations of Vietnam Types of soil (with a correlation coefficient R^2 =0.91) is as follows.

E_0 =4.68×CBR+12.48（filling sand） (MPa); B-5

E_0 of subgrade is ngiven 4.68*CBR+12.48＝4.68*6.0+12.48＝40.6(MPa). In case of H/D>2 formation is change to follows.

F.1 Approximate formula to calculate elastic module

$$E_{ch}=\frac{1+\frac{E_0}{E_1}}{\sqrt{1+4\left(\frac{H}{D}\right)^2\left(\frac{E_0}{E_1}\right)^{-0.67}}}$$

(ii) Review of Pavement design (6 lanes and new construction)

The comparison of the pavement design between VEC FS and JST is shown in Table 3.2.1-23.

Table 3.2.1-23 The comparison of the pavement design between VEC FS and JST

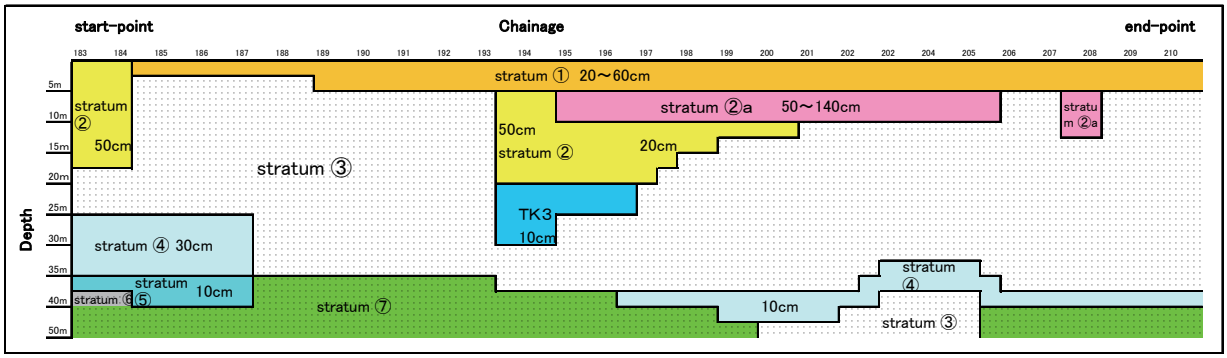
	VEC FS		JST	
SECTION / LAYER	Phap Van-Thuong Tin Thickness (cm)	Thuong Tin-Cau Gie Thickness (cm)	Phap Van-Thuong Tin Thickness (cm)	Thuong Tin-Cau Gie Thickness (cm)
Asphalt concrete Surface Course	5	5	5	5
Asphalt concrete Binder Course	7	7	7	7
Porous asphalt concrete	10	10	10	10
Macadam aggregate type1 with cement 6%	22	22	35	35
Macadam aggregate type2	25	30	35	35

Roughness Layer is added to the top layer as wearing layer (3cm). Roughness layer is not included as layer of pavement design because that is wearing course.

Due to the increase in traffic volume forecast, corresponding necessary elastic modulus also increases. It is understood that increase in aggregate layers for reconstruction or new construction is larger than those for overlay because overlay evaluates a strength of the existing pavement.

3.2.1.7 Counter measures for preventing settlements

PVCG Highway was constructed on the soft ground. Although approx. ten years have been past, consolidation settlements are observed. There are level differences at the boundary between Structures supported by piles, such as bridges or box culverts, and typical embankment section. While Structures supported by piles has little settlement, typical embankment section has at certain level of settlement in spite of countermeasures for settlements, ie. Prefabricated Vertical Drain (PVD). This uneven settlements cause level differences. In PV-CG Highway, there seems to be settlements as much as 1m. Soft layers which generate considerable consolidation settlements, such as layer 1, layer 2a and layer 2 shown in the following Figure, exist at the depth between 10m to 20m from the ground level.



No.	Outline of Stratum	No.	Outline of Stratum
Stratum ①	medium hard - hard clay	Stratum④	hard clay
Stratum②a	soft - very soft organic clay	Stratum⑤	hard - very hard clay
Stratum②	soft - very soft clay	Stratum⑥	moderate dense sand
Stratum③	medium dense sand	Stratum⑦	hard dense sand
TK3	very hard clay		

Source : GEOTECHNICAL ENGINEERING REPORT, August 1997

Figure 3.2.1-18 Geotechnical Longitudinal Section

In VEC FS, geological investigation was carried out and countermeasures were studied. Countermeasures included in VEC FS are introduced. As stated in VEC FS, the documents collected, such as detailed design drawing, as-built drawings and maintenance record, are not enough for studying countermeasures in detail. At the Detailed Design stage, it is necessary to re-study countermeasures in detail after collecting the documents mentioned above and carrying out an additional geological investigation. A Geological Longitudinal Section made from geological investigation ordered by C-NEXCO is attached to Attachment.

(1) Allowable residual settlements

Allowable residual settlements are shown in the following Table.

Table 3.2.1-24 Allowable residual settlements (Sr)

Location	Value
Typical Embankment Section	Sr≦30cm

Box Culvert Section	Sr≦20cm
Bridge Section	Sr≦10cm

(2) Countermeasures for Existing 4-lane

Design specifies Allowable residual settlements (Sr) is not greater than 10cm for Typical Embankment Section in order to minimize level differences at the connection part between existing 4-lane and widening part (one lane at each side), also standard specifies Sr is not greater than 30 cm. To achieve this target, Deep Mixing Method of Stabilization is applied to Box Culvert Section and Typical Embankment Section where Sr is greater than 10 cm.

(3) Countermeasures for widening parts

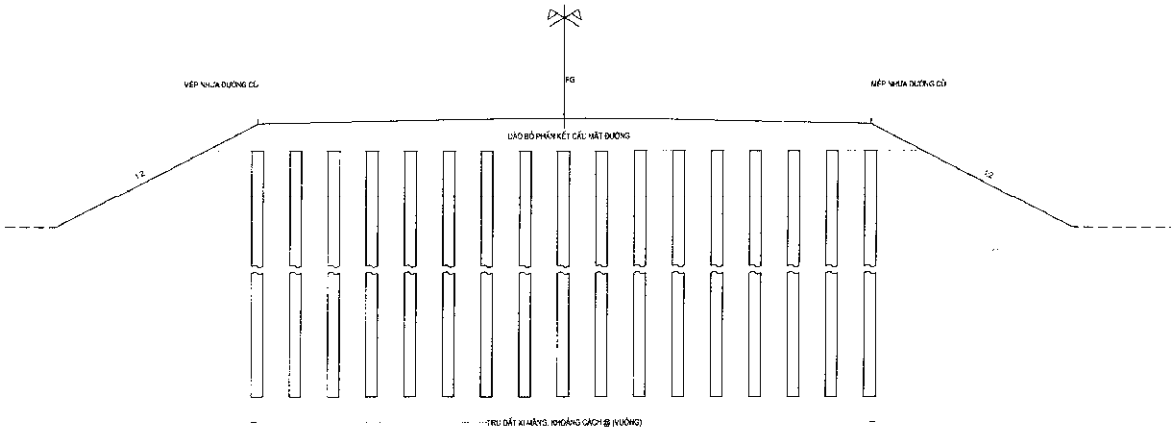
For widening part, most economical method, such as PVD plus surcharge, is designed. Thickness of surcharge is 60 cm and surcharge is to be made at 5cm/day.

Table 3.2.1-25 List of Box Culvert for Deep Mixing Method of Stabilization

No.	Station			No.	Station		
1	KM191+616.8	～	KM191+636.8	18	KM200+524.8	～	KM200+544.8
2	KM191+639.3	～	KM191+659.3	19	KM200+978.3	～	KM200+998.3
3	KM194+837.8	～	KM194+857.8	20	KM201+001.8	～	KM201+021.8
4	KM194+860.3	～	KM194+880.3	21	KM202+916.3	～	KM202+936.3
5	KM195+837.3	～	KM195+857.3	22	KM202+939.8	～	KM202+959.8
6	KM195+860.8	～	KM195+880.8	23	KM203+648.3	～	KM203+668.3
7	KM196+874.8	～	KM196+894.8	24	KM203+671.8	～	KM203+691.8
8	KM196+897.3	～	KM196+917.3	25	KM205+318.3	～	KM205+338.3
9	KM197+890.0	～	KM197+941.0	26	KM206+341.3	～	KM205+361.8
10	KM197+947.0	～	KM197+997.0	27	KM206+318.3	～	KM206+634.8
11	KM198+729.8	～	KM198+749.8	28	KM206+614.8	～	KM206+657.3
12	KM198+752.3	～	KM198+772.3	29	KM206+637.3	～	KM207+884.0
13	KM199+101.3	～	KM199+121.3	30	KM207+890.0	～	KM207+910.0
14	KM199+124.8	～	KM199+144.8	31	KM208+651.3	～	KM208+671.3
15	KM199+953.0	～	KM199+973.0	32	KM208+674.8	～	KM208+694.8
16	KM199+979.0	～	KM19+999.0	33	KM209+454.3	～	KM209+474.3
17	KM200+501.3	～	KM200+521.3	34	KM209+447.8	～	KM209+497.8

Table 3.2.1-26 List of PVD Sections (Typical Embankment)

TT	Lý trình	Cự ly (m)	Chiều cao đắp cạp (m)	Nội dung xử lý												
				Giếng cát (SD) hoặc Bấc thấm (PVD)			Chiều dày cát đệm (m)	Tiến trình đắp					Bệ phản áp bxh (m)	Độ cố kết U (%)	Độ lún còn lại Sr (m)	Chiều dày bù lún (m)
									Giai đoạn 1		Giai đoạn 2					
				SD/ PVD	Khoảng cách d (m)	Chiều sâu D (m)		Tốc độ đắp cm/ngày	Chiều cao (m)	Thời gian chờ cố kết T1 (ngày)	Chiều cao (m)	Thời gian đợi T2 (ngày)	Tổng thời gian thi công (ngày)			
1	KM 182+450.0 - KM 182+877.0	427	3.2	PVD	1.5	17.2	0.6	5	FG+0.5	210			288		91.1	0.05	0.67
	Cầu Vàn Điền																
2	KM 183+050.0 - KM 184+850.0	1800	3.2	PVD	1.5	17.7	0.6	5	FG+0.9	210			296		92.1	0.04	0.58
3	KM 184+850.0 - KM 189+650.0	4800	2.0	không xử lý													
4	KM 189+650.0 - KM 190+850.0	1200	2.4	PVD	1.5	15.8	0.6	5	FG+0.4	210			267		93.8	0.02	0.41
5	KM 190+850.0 - KM 191+450.0	600	2.7	PVD	1.5	15.8	0.6	5	FG+0.4	210			272		90.1	0.03	0.35
6	KM 191+450.0 - KM 192+000.0	550	3.5	PVD	1.5	16.0	0.6	5	FG+0.5	210			298		90.2	0.08	0.84
7	KM 192+000.0 - KM 192+861.0	861	1.2	không xử lý													
8	KM 193+200.0 - KM 194+350.0	1150	2.2	PVD	1.5	16.0	0.6	5	FG+0.5	210			262		91.1	0.03	0.38
9	KM 194+350.0 - KM 195+150.0	800	2.0	không xử lý													
10	KM 195+150.0 - KM 196+414.0	1264	2.2	PVD	1.5	13.0	0.6	5	FG+0.8	210			271		91.6	0.02	0.32
11	KM 196+414.0 - KM 198+550.0	2136	1.8	không xử lý													
12	KM 198+550.0 - KM 200+600.0	2050	3.0	PVD	1.5	17.0	0.6	5	FG+0.4	210			278		91.3	0.03	0.35
13	KM 200+600.0 - KM 202+031.0	1431	3.0	PVD	1.5	8.30	0.6	5	FG+0.3	210			294		97.1	0.01	0.21
14	KM 202+031.0 - KM 204+000.0	1969	2.5	không xử lý													
15	KM 204+000.0 - KM 204+110.0	110	6.0	PVD	1.5	7.00	0.6	5	3	90	FG+0.3	120	341	8x3	95.1	0.02	0.51
	Cầu Vạn Điểm																
16	KM 204+290.0 - KM 204+400.0	110	6.0	PVD	1.5	15.5	0.6	5	3	90	FG+0.3	120	351	8x3	97.0	0.03	1.02
17	KM 204+400.0 - KM 205+150.0	750	1.5	không xử lý													
18	KM 205+150.0 - KM 210+500.0	5350	3.0	PVD	1.5	13.5	0.6	5	FG+0.4	210			278		90.1	0.03	0.37
19	KM 210+500.0 - KM 211+256.0	756	4.0	không xử lý													



BẢNG TỔNG HỢP CÁC CỐNG HỘP CẦN XỬ LÝ PHẦN NỀN ĐƯỜNG ĐẦU CỐNG

Lý trình	
Cầu Vàn Điền	
CỐNG HỘP	KM 191+638.0
CỐNG HỘP	KM 195+857.0
CỐNG HỘP	KM 197+950.0
Cầu Vạn Điểm	
CỐNG HỘP	KM 208+680.0

SƠ ĐỒ BỐ TRÍ TRỤ ĐẤT XI MĂNG @=1.6

GHI CHÚ:

1. KÍCH THƯỚC GHI TRÊN BẢN VẼ ĐỀU ĐƠN VỊ LÀ MÉT, TRỪ KHI CÓ CHỈ ĐỊNH KHÁC;
2. CHIỀU SÂU PHỤ ĐẤT XI MĂNG CÓ THỂ THAY ĐỔI THEO SỰ PHÂN BỐ ĐẤT YẾU;
3. CỐNG RÃNH ĐƯỢC THI CÔNG SAU KHI TRỤ ĐẤT XI MĂNG ĐẠT YÊU CẦU;
4. FG: CAO ĐỘ THIẾT KẾ.
5. CÁC YÊU CẦU VỀ VẬT LIỆU, THI CÔNG TUÂN THỦ CHỈ DẪN KỸ THUẬT CỦA DỰ ÁN;
6. PHẠM VI XỬ LÝ CHO 1 BÊN CỐNG L=12M (ĐẤT ĐẮP TỪ SAU BẢN QUÁ ĐỘ);

Figure 3.2.1-19 Layout of Deep Mixing Method of Stabilization

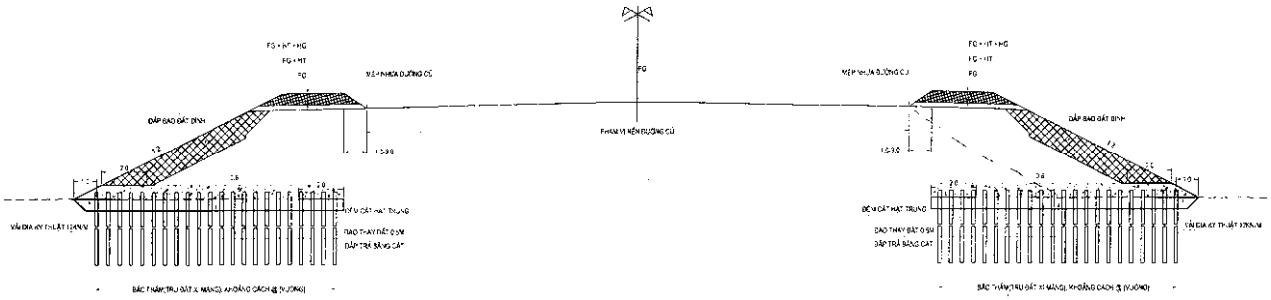


Figure 3.2.1-20 Layout of Prefabricated Vertical Drain (PVD)

3.2.2 Structure

In Study Area as main structure, there are 52 Box culverts for road, 105 Pipe culverts for drainage, 1 studying new bride for frontage road, 2 bridge for Expressway and 2 overpass bridge crossing Expressway.

Present Conditions and Design Policies for each structure are as follows.

3.2.2.1 Present Condition and Design Policy

(1) Box Culvert for Road (Phase Ⅰ)

a. Present Condition

Box culverts for road are 52 in Survey Area. Type of Inner size is 8 type, and Type of Inner size 2.5m square, the number of them is 19 and most common. Result in site survey, these Box culvert are good condition as non-damage. The list of Box culverts for road indicates in Appendix and the list of Type is as follows.

Table 3.2.2-1 The list of Box culverts for road

Size		The number of Box culverts
Inner width(m)	Inner height (m)	
2.5	2.5	19
3.5	2.5	15
3.5	3.2	3
3.5×2	3.2	2
4.0	2.5	1
4.0	3.2	3
5.0	3.6	2
6.0	3.6	7
Total		52

B2.5m,H2.5m

B3.5m×2,H3.2m

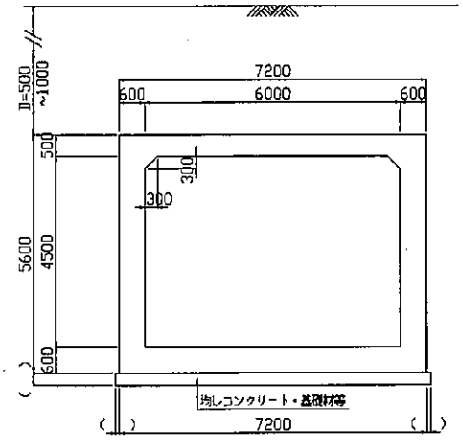
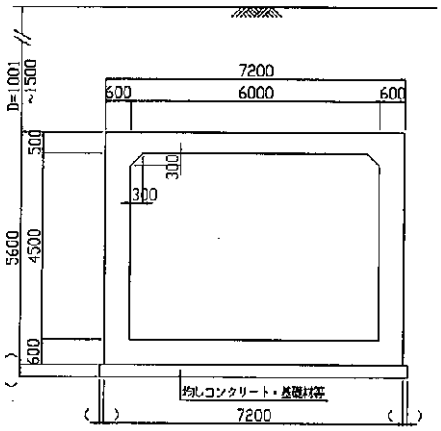
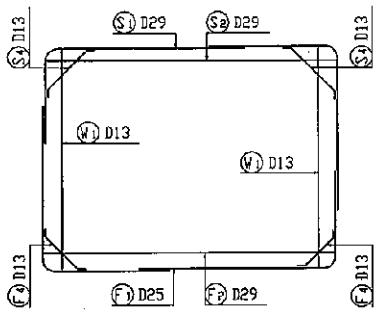
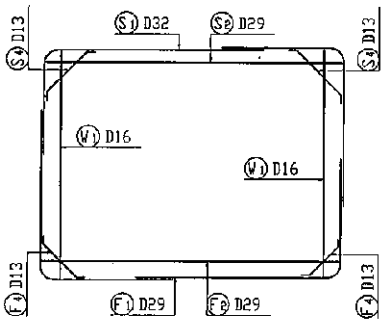
Figure 3.2.2-1 Existing Box culvert

b. Design Policy

The existing box culverts are made from reinforced concrete. The existing box culverts would need to be extended with the widening of PVCG Expressway and the additional extensions will be of the same inner size and shape with the existing structures.

Structure dimension and bar arrangement of the box culvert may be affected by the overburden as shown in Example. The vertical alignment of PVCG Expressway will be improved and the overburden on some box culvert will be deeper than that of existing one. Therefore structural soundness of the box culvert is checked. Checking Results shows that stress generated in the box culvert is within an allowable stress. Because increase in the overburden on box culvert may shorten its design life and may cause adverse effects by unexpected action of the load, it should be minimized. In the Detailed Design stage, decrease in overburden on the box culvert is to be studied by review of vertical alignment and pavement design, and structural soundness is to be checked.

Example: BOX 6.0×4.5, Extract from Japanese Standard Drawings

	Overburden D=500～1000	Overburden D=1001～1500
Size		
Placing Reinforcement		

(2) Box culvert for drainage (Phase Ⅰ)

a. Present Condition

It seems that Box culverts for drainage are 105 on survey area. But Site survey was tried, it was impossible we confirm them account for growing thick plants. So location and size of Box culvert for drainage are confirmed by plan and parts of drawings provided from Vietnamese government.

They are divided 16 type by different of shape Type of Inner diameter is1.25m and the number of them is 19 and most common. The list of Pipe culverts for road indicates Appendix and the list of Type is as follows.

Table 3.2.2-2 The list of Pipe culverts for road

Size			The number of Box culverts
Box Culvert		Pipe Culvert	
Inner width(m)	Inner height (m)	Inner Diameter(m)	
-	-	1.00	18
-	-	1.20	3
-	-	1.25	52
-	-	1.30	1
-	-	1.50	2
-	-	1.50×2	1
1.5	1.5	-	12
1.5	2.0	-	1
1.5×2	1.5	-	3
2.0	2.0	-	1
2.0×2	2.0	-	2
2.5	2.5	-	1
2.5×2	2.5	-	3
3.0	3.0	-	2
3.0×2	3.0	-	2
3.5×2	3.0	-	1
Total			105

	
ϕ 1.25m	B2.5m×2,H2.5m

Figure 3.2.2-2 Existing Pipe culvert for drainage

b. Design policy

Pipe culvert is reinforced concrete structure. According to widening PVCG road, these need to be extended at existing inner size and shape.

(3) Frontage Road Bridge (Phase Ⅰ)

a. Present Condition

Frontage road is planned to be constructed between km182+800 and km211+300 west and between km182+950 and km206+60 east. On west sides the bridge is needed because of crossing over To Lich River(nearby km182+900). Main line of expressway crosses over To Lich River, so bridge of frontage road will be planned to parallel to the bridge of expressway and to cross over To Lich River.

	
Looking from south west (end-point side)	Administrative way from south (end-point side)

Figure 3.2.2-3 Van Dien Bridge

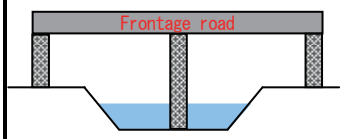
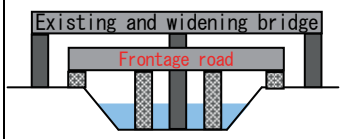
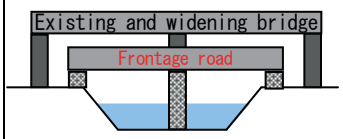
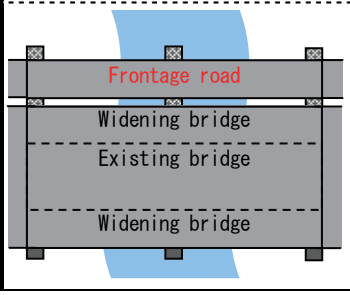
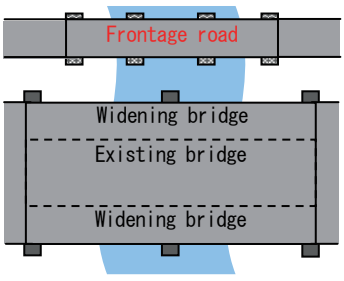
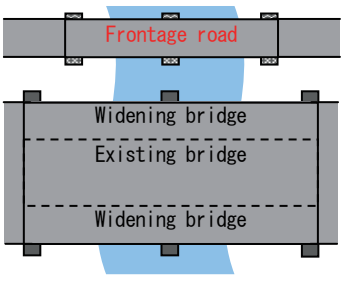
b. Design Policy

Design Policy of Frontage Road Bridge is as follow.

- The type of structure is decided in considering harmonious with nearby landscape.
- The type of structure is decided in considering maintenance
- Bridge design is conducted considering keeping administrative way's space.
- The type of structure is decided in considering an estimated high level water level of To Lich River.

Types of superstructures are compared as shown below. Type of superstructure is to be of PC-I girder, which was determined to be optimum in landscape and land acquisition.

Table 3.2.2-3 Comparison of type of superstructure

Type of superstructure	PC-I girder bridge	RC slab bridge	Plate girder bridge
The length of bridge	Approx.65m	Approx.50m	Approx.50m
Span	2span	3span	2span
Outline	Form and location of this bridge are same form, construction adjacent positions respectively.	Bridge length will be shorter and construction cost will to be reduced. Construction position of this bridge is offset from expressway at a certain distance because space of administrative road is obstructed by this bridge	Bridge length will be shortest and construction cost will to be reduced. Construction position of this bridge is offset from expressway at a certain distance because space of administrative road is obstructed by this bridge
Advantage	Landscape is better than others because this bridge is parallel to expressway. Land acquisition is controlled minimal scope.	Bridge length can be shorter than the steel construction and maintenance costs are reduced.	The burden of substructure can be reduced because weight of superstructure is light compare to other proposal.
Disadvantage	Construction costs are higher compared to other proposals for a longer bridge length.	Landscape is worse than others because of difference of height of bridge and difference of bridge form Because offset from expressway to frontage road expand, land acquisition is also expanded. Because bridge pier is many, so there is a risk of adverse effects on river flows down.	Landscape is worse than others because of difference of height of bridge and difference of bridge form Because offset from expressway to frontage road expand, land acquisition is also expanded. Because metal bridge is required periodic painting, maintenance cost is increase.
Figure of Vertical image			
Figure of plane image			

(4) Bridge(Phase Ⅱ)

a. Present Condition

PVCG road has two bridges, Van Dien Bridge and Van Diem Bridge. As a result of site survey, they are non-damage and good condition.

Table 3.2.2-4 Outline of Expressway bridge

The name of Bridge	Station	Length	Superstructure	Span	The length of span	The Width of road
Van Dien Bridge	Km182+920	66.15m	PC-I girder	2span	32.2m	12.0m one side
Van Diem Bridge	Km204+191	165.30m	PC-I girder	5span	32.2m	12.0m one side

Figure 3.2.2-4 Van Dien Bridge

b. Design Policy

It is confirmed that design load of Van Dien Bridge is H30-XB80(HS20-44×1.25) form as-built drawing.so it is considered that Existing Van Dien Bridge were adopted for Vietnam Standard. And it is considered that Van Dien Bridge was built as design condition. So on this time survey, checking existing structure don't be conducted and only study on widening is conducted.

Widening parts are widened 4.25m, and the type of superstructure is decided PC-I girder considering workability, economy and ease of maintenance and being same superstructure of existing Van Dien Bridge.(comparison of superstructure from the report of past survey are conducted.)

Table 3.2.2-5 Outline of widening Expressway bridge

The name of bridge	Superstructure	Length	The length of widening
Van Dien Bridge	PC-I girder	66.15m	4.75m
Van Diem Bridge	PC-I girder	165.30m	4.75m

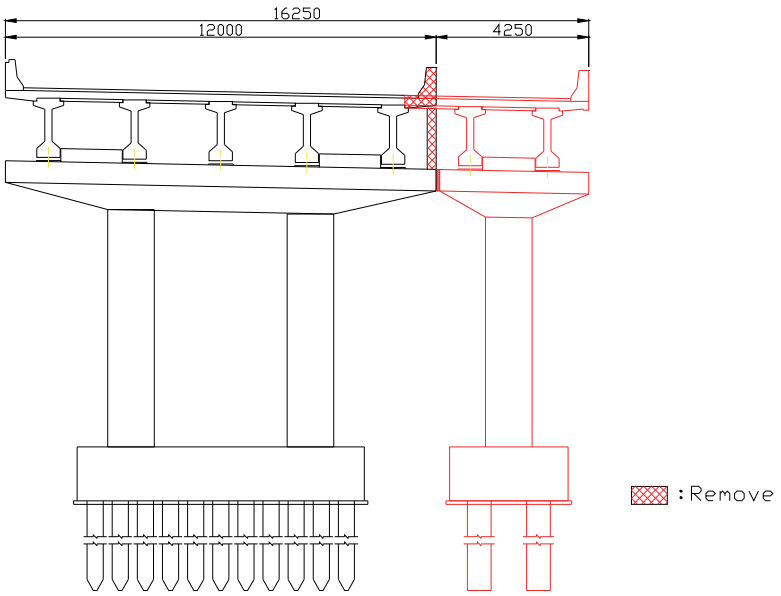


Figure 3.2.2-5 Cross section

(5) Over pass (Phase Ⅱ)

a. Present Condition

Crossing expressway Overpass on survey site is two bridge, Tu Khoat Flyover and Khe Hoi Flyover

As a result of site survey, these bridges are confirmed that main girder was lightly damaged and drainage was deteriorated. These injuries are not urgent, but thought to be repaired at the time of four-lane highway.

Table 3.2.2-6 List of overpass

The name of bridge	Station	Superstructure	Span
Tu Khoat Flyover	km186+720	PC-I girder	8span
Khe Hoi Flyover	km192+873	PC-I girder	6span

	
Tu Khoat Flyover (km186+720)	Khe Hoi Flyover(km192+873)
	
Chipped main girder(Tu Khoat Flyover)	Aging drainage(Khe Hoi Flyover)

Figure 3.2.2-6 Present condition of flyovers

b. Design Policy

The results of the investigations show that the clearances under the girder of Tu Khoat Flyover Bridge and Khe Hoi Flyover Bridge are within standards; with clearances of 4.25m. These clearances will be kept sufficient when road is overlaid and upgraded, when additional widening to 6 lanes will be undertaken. So the Study Team does not carry out any design for these Flyovers.

3.2.3 Construction Method Statement

3.2.3.1 Sequence of Construction

The project for Phase I is to upgrade existing 4-lane Highway to Expressway. To satisfy the standard of Expressway, planned level of pavement surface is raised by maximum 1.8m due to vertical alignment improvement. Embankment is to be made as per new planned level. Paving and installation of guard rails follows.

Construction sequence is as shown in the following flow chart.

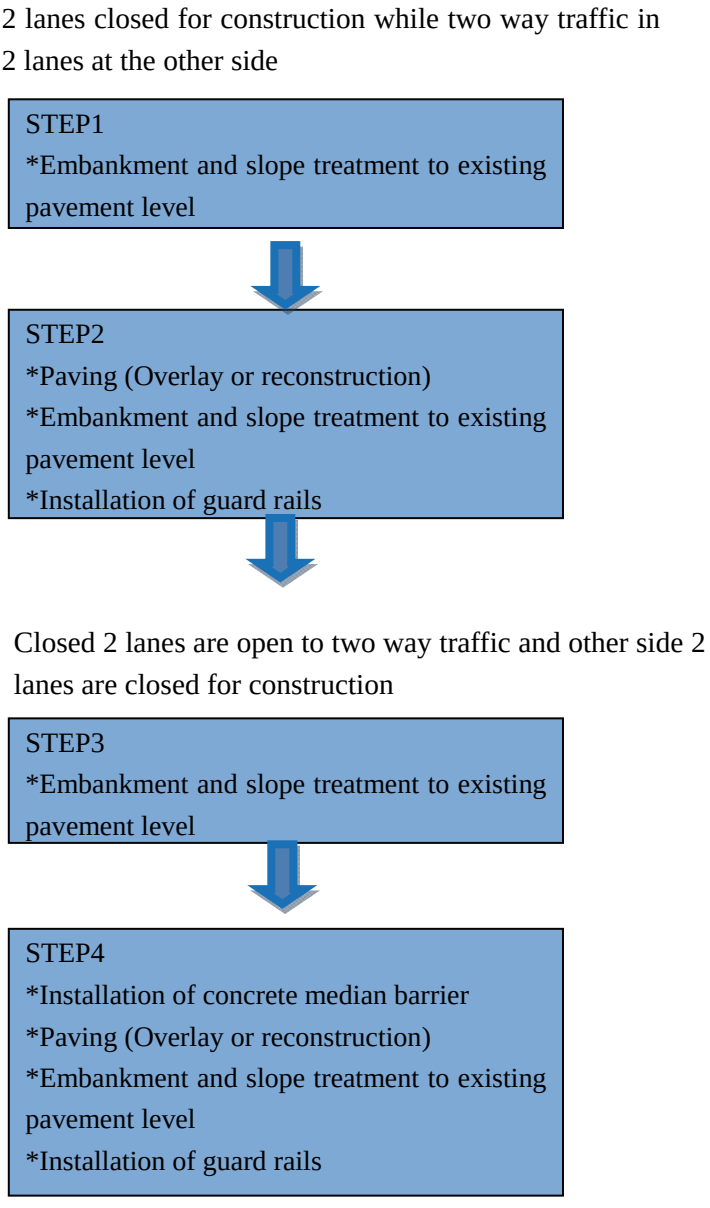
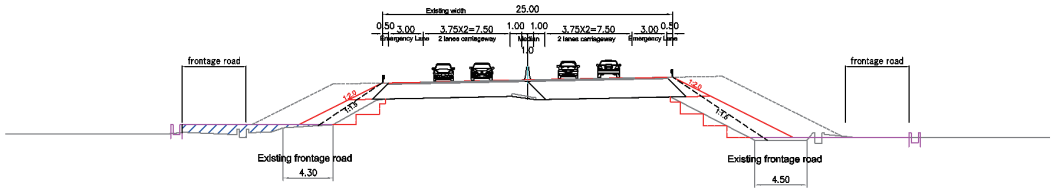


Figure 3.2.3-1 Sequence of Construction

Sequence of construction, construction mashine list and outline construction schedule for Phase I are shown in the next page onwards.

Construction process: Embankment, Slope protection are implemented on one side. after that , Pavement is implemented. And then same processes are conducted on an another side.

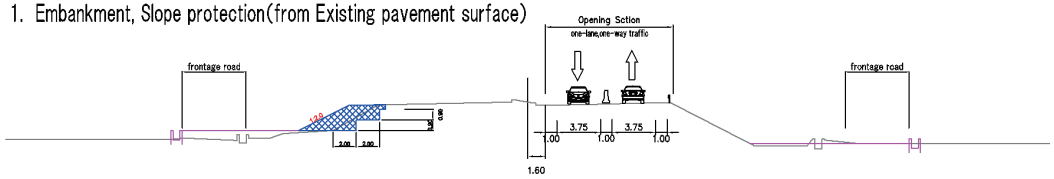
Complete cross-section(STEP5)



STEP1

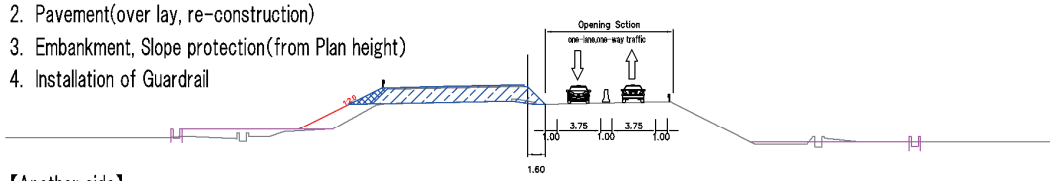
【One side】

1. Embankment, Slope protection(from Existing pavement surface)



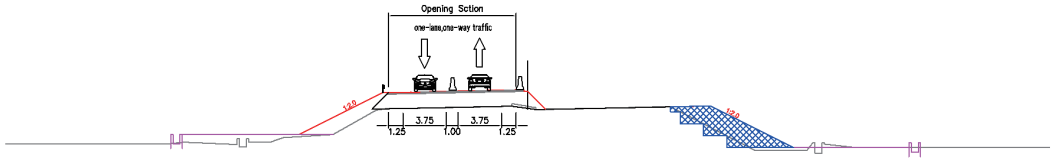
STEP2 【One side】

2. Pavement(over lay, re-construction)
3. Embankment, Slope protection(from Plan height)
4. Installation of Guardrail



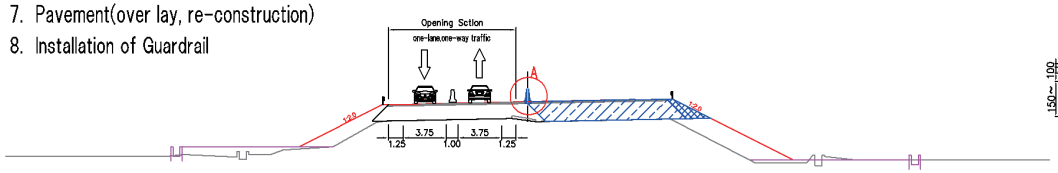
STEP3 【Another side】

5. Embankment, Slope protection(from Existing pavement surface)



STEP4

6. Installation of Concrete Barriers
7. Pavement(over lay, re-construction)
8. Installation of Guardrail



A(Concrete barriers)part Detail

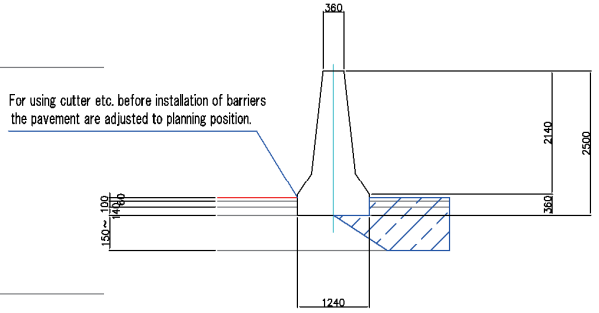


Figure 3.2.3-2 Construction Process (Phase I)

Construction process：Installation PVD and surcharge for widening part, standing for a period, after that, doing Excavation and Removable Surcharge, Pavement, Installation of Guardrail

Complete cross-section(STEP5)

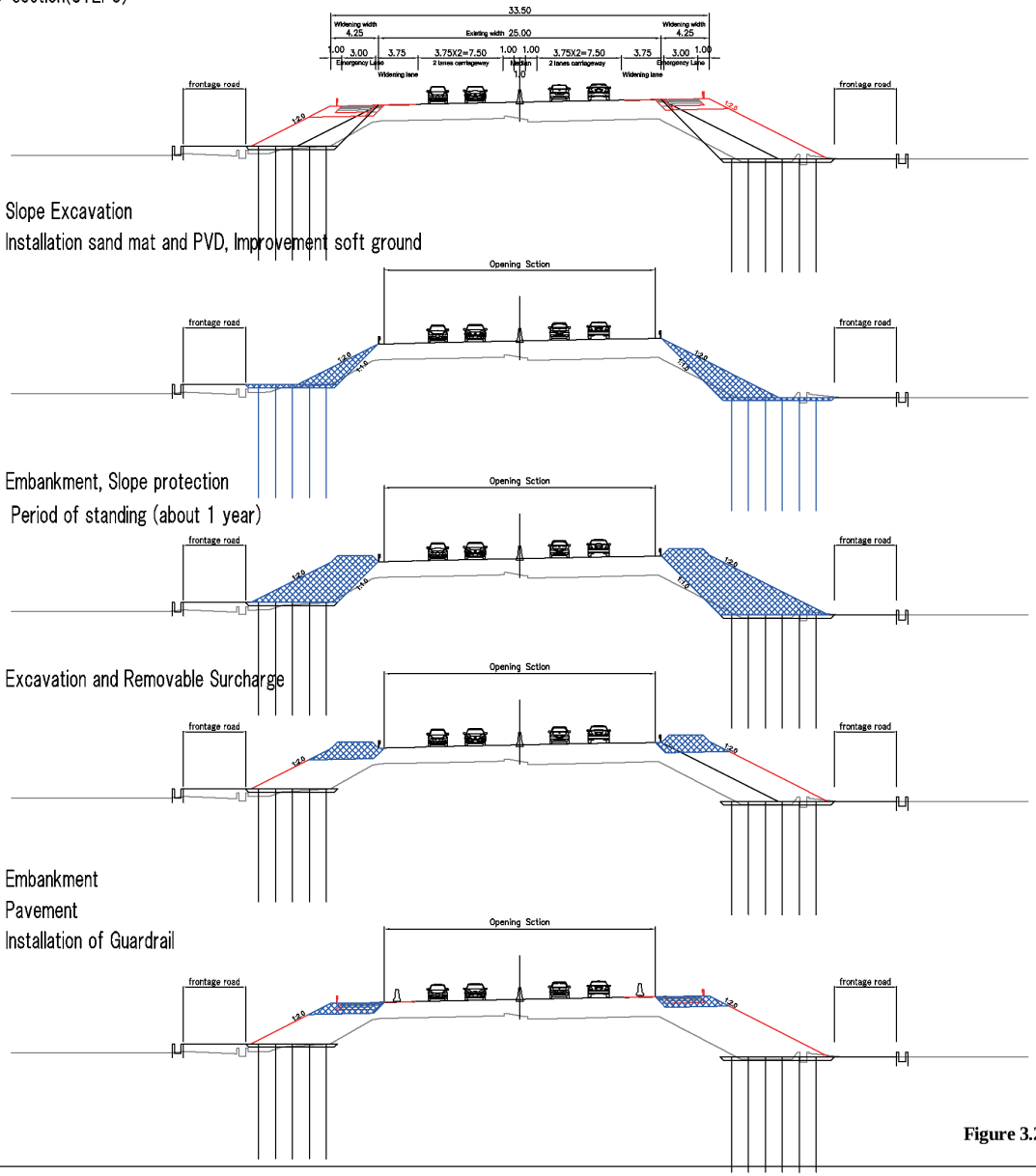


Figure 3.2.3-3 Construction Process (Phase II)

Table 3.2.3-1 Outline Construction Schedule (Phase I)

Area	Unit Price Code	Norm Code	Description	unit	Total Quantity	Work Rate (8 Hours)	Workable Weather Rate (%)	Work Duration per 1set (days)	Work Party (Set)	Work Duration (days)	Year 1 M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	Year 2 M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	Remarks
SECTION 1～ SECTION 6			A MAIN ROAD								SECTION 1			SECTION 2			SECTION 3		SECTION 4		SECTION 5			SECTION 6											
			A MAIN ROAD																																
			I EMBANKMENT																																
	ĐG1		Site clearing	m2	220,395	1,500	74%	199	4	50																									
	TH- 1		Road Excavation	m3	**32,176**	1,500	74%	29	4	7																									
	TH- 2		Embankment K95	m3	**168,873**	300	74%	761	8	95																									
	ĐG9		Embankment K98	m3	3,450	300	74%	16	4	4																									
	ĐG104		Embankment K98 (not including material)	m3	**9,609**	300	74%	43	4	11																									
	ĐG11	AL 17111	Grasses for slope protection	m2	**217,480**	500	83%	524	5	105																									
	TH- 31		Excavation of existing road	m3	8,426	200	74%	57	4	14																									
	II		PAVEMENT																																
	TH- 3		Asphalt Concrete Roughness Layer-thickness 3cm	m2	**388,162**	3,500	74%	150	4	37																									
	TH- 4		Asphalt Concrete Surface Course-thickness 5cm	m2	**509,836**	3,500	74%	197	4	49																									
	TH- 5		Asphalt Concrete Binder Course-thickness 7cm	m2	**514,182**	3,500	74%	199	4	50																									
	TH- 6		Porous Asphalt Concrete-thickness 10cm	m2	**12,250**	1,225	74%	14	4	3																									
	ĐG34		Base course (Aggregate type 1 + 6%cement)	m3	**82,437**	600	74%	186	2	93																									
	ĐG33	AD 11212	SubBase course (Aggregate type 2)	m3	4,428	225	74%	27	2	13																									
	ĐG29	AD 24211	Bituminous Tack Coat 0.6kg/m2	m2	**388,162**	3,500	74%	150	4	37																									
	ĐG30	AD 24213	Bituminous Tack Coat 1.0kg/m2	m2	**509,836**	3,000	74%	230	4	57																									
	ĐG31	AD 24214	Bituminous Prime Coat 1kg/m2	m2	**514,182**	3,500	74%	199	4	50																									
	III		TREATED SOFT SOIL																																
			Soil cement columns	m	39,498	45	83%	1,057	5	211																									
	IV		MISCELLANEOUS																																
	TH- 10		Removal of Median strip	m	43,240	1,500	74%	39	2	19																									
	TH- 48		Proposed Concrete Median	each	**4,271**	15	83%	343	5	69																									
	TH- 12		Removal of existing Guardrail	m	86,481	300	83%	347	5	69																									
	TH- 47		Reinstallation of 30% existing guardrail after repair	m	25,944	200	83%	156	4	39																									
	TH- 8		Installation of Guardrail	m	**17,828**	200	83%	107	4	27																									
	ĐG94	AA 21511	Removal of Boundary barbed wire Fence	m2	43,240	200	83%	260	5	52																									
	ĐG103		Removal of Trees	each	**10,677**	10	83%	1,286	10	129																									
	TH- 28		Shrubs for Outer separation (additional)	each	4,325	10	83%	521	10	52																									
			Shoulder Retaining Wall	m	3,300	30	83%	133	2	66																									
	V		TRAFFIC ORGANIZATION																																
	ĐG38	AK.91131	Reflective Road Marking	m2	29,984	400	74%	101	2	51																									
	ĐG40	AD 32421	Circle Guide Sign D1.26m	each	2	10	83%	0	1	0																									
	ĐG39	AD 32421	Circle Guide Sign D0.7m	each	63	10	83%	8	2	4																									
	ĐG41	AD 32431	Triangle Warning Signs 0.7m	each	131	10	83%	16	2	8																									
	ĐG43	AD 32441	Rectangular Sign	m2	95	10	83%	11	2	6																									
	ĐG45	AD 32131	Steel post for Guide Sign 3.4m	each	54	10	83%	6	2	3																									
	ĐG44	AD 32131	Steel post for Guide Sign 3.7m	each	84	10	83%	10	2	5																									
		TT	Removal of Traffic Sign	each	458	10	83%	55	2	28																									
		TT	Removal of Advertisement Board	each	92	10	83%	11	2	6																									
	B		INTERCHANGE																																
	II		PAVEMENT																																
	TH- 4		Asphalt Concrete Surface Course-thickness 5cm	m2	4,779	1,500	74%	4	1	4																									
	ĐG30	AD 24213	Bituminous Prime Coat 1kg/m2	m2	4,779	1,500	74%	4	1	4																									
	IV		TRAFFIC ORGANIZATION																																
	ĐG38	AK.91131	Reflective Road Marking	m2	1,120	200	74%	8	2	4																									
	ĐG40	AD 32421	Circle Guide Sign D1.26m	each	6	10	83%	1	2	0																									
	ĐG39	AD 32421	Circle Guide Sign D0.7m	each	10	10	83%	1	2	1																									
	ĐG41	AD 32431	Circle Guide Sign D0.7m	each	4	10	83%	0	2	0																									
	ĐG42	AD 32431	Triangle Warning Signs 1.26m	each	1	10	83%	0	2	0																									
	ĐG43	AD 32441	Rectangular Sign	m2	99	10	83%	12	2	6																									
	ĐG45	AD 32131	Steel post for Guide Sign 3.4m	each	7	10	83%	1	2	0																									
	ĐG44	AD 32131	Steel post for Guide Sign 3.7m	each	11	10	83%	1	2	1																									
		TT	Steel sign post D200, L=6.2m	each	10	10	83%	1	2	1																									
		TT	Overhead Gantry	each	2	0.1	83%	24	1	24																									
		TT	cantilever arm	each	4	0.1	83%	48	2	24																									
SECTION 7～ SECTION 10			A MAIN ROAD								SECTION 10			SECTION 9			SECTION 8		SECTION 7																
			A MAIN ROAD																																
			I EMBANKMENT																																
	ĐG1		Site clearing	m2	**74,782**	1,500	74%	67	3	22																									
	TH- 1		Road Excavation	m3	**10,918**	1,500	74%	10	3	3																									
	TH- 2		Embankment K95	m3	**38,452**	300	74%	173	3	58																									
	ĐG9		Embankment K98	m3	2,070	300	74%	9	3	3																									
	ĐG104		Embankment K98 (not including material)	m3	**3,261**	300	74%	15	3	5																									
	ĐG11	AL 17111	Grasses for slope protection	m2	**73,793**	500	77%	192	5	38																									
	TH- 31		Excavation of existing road	m3	5,055	200	74%	34	3	11																									
	II		PAVEMENT																																
	TH- 3		Asphalt Concrete Roughness Layer-thickness 3cm	m2	**131,706**	3,500	74%	51	3	17																									
	TH- 4		Asphalt Concrete Surface Course-thickness 5cm	m2	**172,992**	3,500	74%	67	3	22																									
	TH- 5		Asphalt Concrete Binder Course-thickness 7cm	m2	**174,466**	3,500	74%	67	3	22																									
	TH- 6		Porous Asphalt Concrete-thickness 10cm	m2	**7,350**	1,225	74%	8	3	3																									
	ĐG34		Base course (Aggregate type 1 + 6%cement)	m3	**28,621**	600	74%	64	1	64																									
	ĐG33	AD 11212	SubBase course (Aggregate type 2)	m3	2,657	225	74%	16	1	16																									
	ĐG29	AD 24211	Bituminous Tack Coat 0.6kg/m2	m2	**131,706**	3,500	74%	51	3	17																									
	ĐG30	AD 24213	Bituminous Tack Coat 1.0kg/m2	m2	**172,992**	3,000	74%	78	3	26																									
	ĐG31	AD 24214	Bituminous Prime Coat 1kg/m2	m2	**174,466**	3,500	74%	67	3	22																									
	III		TREATED SOFT SOIL																																
			Soil cement columns	m	23,699	45	83%	634	5	127																									
	IV		MISCELLANEOUS																																
	TH- 10		Removal of Median strip	m	14,672	1,500	74%	13	2	7																									
	TH- 48		Proposed Concrete Median	each	**1,449**	15	83%	116	5	23																									
	TH- 12		Removal of existing Guardrail	m	29,344	300	83%	118	5	24																									
	TH- 47		Reinstallation of 30% existing guardrail after repair	m	8,803	200	83%	53	4	13																									
	TH- 8		Installation of Guardrail	m	**6,049**	200	83%	36	4	9																									
	ĐG94	AA 21511	Removal of Boundary barbed wire Fence	m2	14,672	200	83%	88	5	18																									
	ĐG103		Removal of Trees	each	**3,623**	10	83%	436	10	44																									
	TH- 28		Shrubs for Outer separation (additional)	each	1,467	10	83%	177	10	18																									
			Shoulder Retaining Wall	m	3,050	30	83%	122	2	61																									
	V		TRAFFIC ORGANIZATION																																
	ĐG38	AK.91131	Reflective Road Marking	m2	10,174	400	74%	34	2	17																									
	ĐG40	AD 32421	Circle Guide Sign D1.26m	each	2	10	83%	0	1	0																									
	ĐG39	AD 32421	Circle Guide Sign D0.7m	each	21	10	83%	3	2	1																									
	ĐG41	AD 32431	Triangle Warning Signs 0.7m	each	45	10	83%	5	2	3																									
	ĐG43	AD 32441	Rectangular Sign	m2	32	10	83%	4	2	2																									
	ĐG45	AD 32131	Steel post for Guide Sign 3.4m	each	18	10	83%	2	2	1																									
	ĐG44	AD 32131	Steel post for Guide Sign 3.7m	each	29	10	83%	3	2	2																									
		TT	Removal of Traffic Sign	each	156	10	83%	19	2	9																									
		TT	Removal of Advertisement Board	each	31	10	83%	4	2	2																									
	B		INTERCHANGE																																
	II		PAVEMENT																																
	TH- 4		Asphalt Concrete Surface Course-thickness 5cm	m2	4,779	1,500	74%	4	1	4																									
	ĐG30	AD 24213	Bituminous Prime Coat 1kg/m2	m2	4,779	1,500	74%	4	1	4																									
	IV		TRAFFIC ORGANIZATION																																
	ĐG38	AK.91131	Reflective Road Marking	m2	1,120	200	74%	8	2	4																									
	ĐG40	AD 32421	Circle Guide Sign D1.26m	each	6	10	83%	1	2	0																									
	ĐG39	AD 32421	Circle Guide Sign D0.7m	each	10	10	83%	1	2	1																									
	ĐG41	AD 32431	Circle Guide Sign D0.7m	each	4	10	83%	0	2	0																									
	ĐG42	AD 32431	Triangle Warning Signs 1.26m	each	1	10	83%	0	2	0																									
	ĐG43	AD 32441	Rectangular Sign	m2	99	10	83%	12	2	6																									
	ĐG45	AD 32131	Steel post for Guide Sign 3.4m	each	7	10	83%	1	2	0																									
	ĐG44	AD 32131	Steel post for Guide Sign 3.7m	each	11	10	83%	1	2	1																									
		TT	Steel sign post D200, L=6.2m	each	10	10	83%	1	2	1																									
		TT	Overhead Gantry	each	2	0.1	83%	24	1	24																									
		TT	cantilever arm	each	4	0.1	83%	48	2	24																									

Table 3.2.3-2 List of Construction Machinery

Period: Month 1 to Month 9

Area	Item	Type of Machine	Capacity	Unit	Quantity	Remarks
Plant	Asphalt Paving	Asphalt Plant (Batching Type)	120ton/hour	UN	7	
		Wheel Loader	2-3m3	UN	7	
	Cement Treated Base Course	Soil Mix Plant (Cement Treated Base)	250-300ton/hour	UN	3	
		Excavator	0.7m3-1.0m3	UN	6	
Site	Clearing & Earth Work	Bulldozer	15ton	UN	11	
		Excavator	0.7m3-1.0m3	UN	11	
		Motor Grader	3.7m	UN	11	
		Single Drum Vibration Roller	10 ton	UN	11	
		Tire Roller	10 ton	UN	11	
		Water Tanker	10,000litter	UN	11	
		Dump Track	10 ton	UN	44	
	Sub base	Motor Grader	3.7m	UN	3	
		Single Drum Vibration Roller	10 ton	UN	3	
		Tire Roller	10 ton	UN	3	
		Water Tanker	10,000litter	UN	3	
		Dump Track	10 ton	UN	12	
	Cement Treated Base Course	Asphalt Paver	2.5m - 6.0m	UN	3	
		Tandem Steel Vibration Roller	8 ton	UN	3	
		Tire Roller	10 ton	UN	3	
		Water Tanker	10,000litter	UN	3	
		Dump Track	10 ton	UN	18	
	Prime & Tack Coat	Tractor	80 hp	UN	7	
		Mechanical Broom	2.0m	UN	7	
		Asphalt Distributor	6,000litter	UN	7	
		Water Tanker	10,000litter	UN	7	
	Asphalt Paving	Asphalt Paver	2.5m - 6.0m	UN	7	
		Tandem Steel Vibration Roller	8 ton	UN	7	
		Tire Roller	10 ton	UN	7	
		Water Tanker	10,000litter	UN	7	
		Dump Track	10 ton	UN	42	
	Soil Cement Column	Boling Machine	-	UN	10	
		Jet Grout Pump	-	UN	10	
	Concrete Barrier	Track Crane	25ton	UN	10	
		Trailer	10ton	UN	10	
	Signboard & Gantry	Track Crane	25ton	UN	4	
		Flat Body Track with Crane	4ton	UN	4	

Period: Month 10 to Month 3 in Year 2

Area	Item	Type of Machine	Capacity	Unit	Quantity	Remarks
Plant	Asphalt Paving	Asphalt Plant (Batching Type)	120ton/hour	UN	4	
		Wheel Loader	2-3m3	UN	4	
	Cement Treated Base Course	Soil Mix Plant (Cement Treated Base)	250-300ton/hour	UN	2	
		Excavator	0.7m3-1.0m3	UN	4	
Site	Clearing & Earth Work	Bulldozer	15ton	UN	8	
		Excavator	0.7m3-1.0m3	UN	8	
		Motor Grader	3.7m	UN	8	
		Single Drum Vibration Roller	10 ton	UN	8	
		Tire Roller	10 ton	UN	8	
		Water Tanker	10,000litter	UN	8	
		Dump Track	10 ton	UN	32	
	Sub base	Motor Grader	3.7m	UN	2	
		Single Drum Vibration Roller	10 ton	UN	2	
		Tire Roller	10 ton	UN	2	
		Water Tanker	10,000litter	UN	2	
		Dump Track	10 ton	UN	8	
	Cement Treated Base Course	Asphalt Paver	2.5m - 6.0m	UN	2	
		Tandem Steel Vibration Roller	8 ton	UN	2	
		Tire Roller	10 ton	UN	2	
		Water Tanker	10,000litter	UN	2	
		Dump Track	10 ton	UN	12	
	Prime & Tack Coat	Tractor	80 hp	UN	4	
		Mechanical Broom	2.0m	UN	4	
		Asphalt Distributor	6,000litter	UN	4	
		Water Tanker	10,000litter	UN	4	
	Asphalt Paving	Asphalt Paver	2.5m - 6.0m	UN	4	
		Tandem Steel Vibration Roller	8 ton	UN	4	
		Tire Roller	10 ton	UN	4	
		Water Tanker	10,000litter	UN	4	
		Dump Track	10 ton	UN	24	
	Soil Cement Column	Boling Machine	-	UN	5	
		Jet Grout Pump	-	UN	5	
	Concrete Barrier	Track Crane	25ton	UN	5	
		Trailer	10ton	UN	5	
	Signboard & Gantry	Track Crane	25ton	UN	2	
		Flat Body Track with Crane	4ton	UN	2	